Recycling of RTOS Systems using Smart Sensor Module

Nishant Mathew Surathu, T.J. Nagalakshmi

Abstract: ***This paper proposes a way to construct a financially cheap environment tracking system using the Raspberry Pi single-board PC. The framework was planned using Python Programming and can be controlled remotely. It takes data about the surrounding area through sensors and logs the environment. Test results exhibited that the framework can precisely gauge temperature, moistness, light level or concentrations of the air contamination. It is ideally a system that is developed to measure environmental factors through its different sensors and produce the output of that environment. Society today has a vast accumulation of various electronic devices and technology has been able to operate at a much more efficient manner as time goes by. For example, considering the role of security in our personal device, until the recent few years it was made able to recognize a user through finger print and run facial matching algorithms to provide a more secluded and private mode of access. Technology is moving towards the age of internet of things where devices are to be connected to the cloud storage servers to perform better. Devices are to be upgraded to smart devices that offer a better and improved role of connectivity and promote security. Simpler units are also being made to operate digitally and offer better connectivity through Wi-Fi and Bluetooth and through the use of machine learning algorithms and neural net techniques, they are made to operate as per the each individual user's life style.***

Keywords: Raspberry Pi, Machine language, Interface, Neural net, Devices, Technology, Connectivity, System, Wi-Fi, Bluetooth, Environment, Module, Sensor, Protocols, Program.

I. INTRODUCTION

Any given smart system is developed to operate according to its environmental factors and the factors surrounding it. To gather this data, a smart system can be created that can take in a variety of inputs in order to make logical judgements that can be perceived as an output. In this case, The smart environment tracking system is designed such that a person can pair it with practically any device, via any communication protocol such as Bluetooth (Built-in to the board) or Wi-Fi (Built-in to the board), to take in its input and to provide the appropriate output.Take a smart home for example, the system could be connected to an air conditioning unit that would maintain the temperature of a given room at a consistent range. The system could thus present the air conditioners processor with environmental data pertaining to both the temperature inside the room as well as outside the room and thus by doing so devise the optimal temperature needed. Suppose it was a very cold winter's night, thus the temperature would best be high to initially warm the user as he enters the home and gradually become lower. Such a system would require complex environmental data to be read as input and thus the Smart RTOS system would be made ideal for such a situation. Any given electronic appliance could thus use the proposed system to operate more efficiently. For example the system could be tuned to operate according to the user's work schedule and thus it would be able to provide the necessary input to operate as needed. Such devices are being made necessary in today's evolving future. As time progresses, so does technology and thus the need for advancement grows with it. Thus the system fabricated is made to promote such advancements for the future. By being able to read environmental data from the device, small scale electronics can also be upgraded to work more efficiently. Doing so would also promote for a cheaper way to synthesize and fabricate smart devices as per every user's needs. The device could also be uploaded into a neural net algorithm that makes it possible to grow with time as per the user's habits making it ideal for future developments. The proposed system is also good for the environment as it would promote a great deal of recycling of electronic waste. Currently, the world is filled with a lot of electronic waste that potentially harm the environment. And thus a lot of research efforts are being poured into providing for a more recyclable and organic form of electronic technology. The Organic LED (OLED) screens are an excellent example of such efforts. The system designed could thus be made to recycle a lot of old and outdated electronic systems by further upgrading them to operate functionally as a smart device.

Revised Manuscript Received on March 25, 2019.

Nishant Mathew Surathu, Student of Saveetha School of Engineering, SIMATS, Chennai.

T.J. Nagalakshmi, assistant professor in Saveetha School of Engineering, SIMATS, Chennai.

II. LITERATURE SURVEY

Many systems exist where the use of sensors have been widely promoted as a base support system in decision making. Lately, Companies like Amazon have made the Amazon Echo and Echo dot which uses an AI (Artificial intelligence) Interface, by the name Alexa [8], which can be used to monitor basic house hold applications. However such device only provide a very basic level of input to the system and can thus not make smart decisions that are based mainly off its environment. Thus, the need for an even smarter system that is able to recognize its owner's custom preferences and schedule is growing rapidly. Such a system needs to be able to grow with the user's tastes and interests and be able to learn from his everyday activities. A smart system such as this would also need a great deal of input in order to be able to make informed and just decisions. For example, suppose the user had left the house without turning off the lights in the house or closing the garage door. The proposed system should be able to learn through the use of Passive IR sensors (or motion detectors) about the lack of

activity within the house hold over a specified period of time and thus be able to make the decision to cut the power supply to the lights automatically or close the respective garage door. [2] Such a device would play a very crucial role in the house holds security and power systems. Through the use of AI and some basic behavioral matching algorithms, the system could be made to improve upon itself over time and become even more convenient and efficient for the user by observing their own personal daily routine. [1] The system could be connected directly to the user's smart phone to also be able to access his daily schedule and provide reminders such as doctor's appointments, scheduled TV episodes to the user. Through the use of the Raspberry Pi 3.0 motherboard, it can also be ensured that the system would be capable of working universally under any conditions as long as the board is provided with the shielding required to protect it against the environment. For example, suppose the Smart RTOS system is to be used facing heavy rain, it would require that the Raspberry Pi be fit with a water proof case in order to ensure that the board would not short circuit. A portable version of the system could also be developed by adding a Lithium Ion battery to meet the power requirements and or by making it solar powered in desert conditions. The system would also need to be made to functionally operate with similar devices which are within its range to maximise upon its data collection. Through the use of more sensors, the range of the system and the decision making algorithm of the AI interface could be improved upon as well.

Many systems are already in existence that operate primarily in the medical field. They are used to monitor the vitals such as the heart beat or the movement of limbs of the patient throught out the day. Such systems are also made aware of the patient's environmental conditions to ensure comfort and provide a detailed analysis for the doctor. The design of the proposed system is similar to these system in the way they operate functionally.

III. DESIGN METHODOLOGY

The proposed system is a computational design project that uses a Raspberry Pi 3.0 to run and operate a sensor network by receiving a network of outputs from different sensors. The outputs are also shared with other electronic systems and media through the communications peripherals that are built-in to the Raspberry Pi system. The flow chart of the system in provided below in Figure 1.

Figure 1: Flow chart of proposed system.

The project takes in analog input from the surrounding region to be able to study the environmental factors around the system. It is to be implemented such that any electronic device can be made into a smart device that operates for regulated power consumption and for better output as per the user's needs at the time.

For example consider a house's power and lighting requirements. Ideally, the system would be able to turn on and off as per the user's location and thus be able to conserve more power and operate better. Even through the invention of the motion sensor light however, the technology cannot be fully considered a smart device through just a single sensor input. [5] However, if a series of lights were to be connected to the smart RTOS system then it would be able to consider multiple factors such as the time of the day and the movement within the room or ambience of the room and so forth and be able to give a more regulated light output while considering the situation at present. Thus the temperature sensor could be used to operate the temperature control subsystems within the house hold such as the fan and air conditioning unit and regulate its output as well and similarly they would operate using the motion sensors that would be able to sense any ongoing activity within the room or also sense the dormancy within the room and turn the system into sleep mode which would conserve power as well as be cost effective to the user. The system is also designed such that it can be made to accommodate multiple sensors that can interface with the existing PIR sensor to track and log environmental data. Suppose the user wanted the system to also function as a motion detecting camera. Instead of using a PIR sensor the proposed system can also be interfaced with the Raspberry Pi camera board for such purposes and be modified to function with security as an additional subsystem to the existing system. The design specifications of the proposed system are not limited to one particular mode of operation and by using a Lithium Ion battery to meet its power requirements it can made portable as well.

A. Raspberry Pi 3.0

The Raspberry Pi 3.0 is a micro-computer or otherwise known as a system on a chip (SoC). It has all the functionalities of a basic computer including all the necessary ports and operates on a Linux based OS named Rasbian. However, it also has the capability to operate under multiple other operating systems depending on the board's functionality. The Raspberry Pi 3.0 has a built-in Bluetooth module and a Wi-Fi module that enables communication and connectivity to other devices. [9]

The board is being used as the foundation of the system through which all the sensors are made to communicate to it directly through the GPIO (General purpose input output) pins provided on the board. It is able to take in the digital input from the sensors and operate by using them to relay commands to the other devices. The Raspberry Pi operates as the heart of the proposed system as it makes the critical decisions and thus provides the necessary commands to the electronic devices to which the Smart RTOS system is connected. The figures presented below show the Raspberry

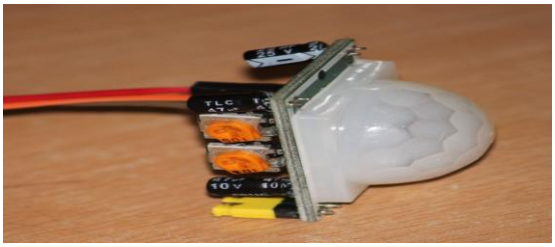


Figure 4: Raspberry Pi PIR sensor module.

Pi 3.0 mother board and the pin configuration of the mother board's GPIO bus terminal along with their corresponding roles and purposes.

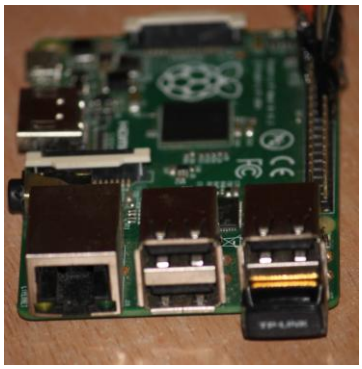


Figure 2: Raspberry Pi 3.0 Mother board.

Figure 3: Raspberry Pi 3.0 GPIO pin diagram. [9]

B. Motion sensor

The motion sensor is a simple Pi Noir sensor that uses infrared detection to track motion through its surroundings. Although it doesn't operate functionally as a camera that is able to perform using an image processing algorithm, it is best suited for this project considering it is cost effective and also able to operate over a large range. [3] The sensor can be used to track the motion of the environment it is placed in and report it back to the Raspberry pi. The following figure shows the PIR module being used in the proposed system.

C. Humidity Sensor

The humidity sensor of the system is used to take in environmental data of the humidity of the environment. It is considered very useful and critical for a temperature moderation system. The sensor provides the Raspberry Pi with the necessary input to regulate the output of electronic devices that moderate the temperature of the room such as the air conditioning unit or the fan and thus keep the temperature at a user set optimal state. The humidity sensor used is shown in Figure 5.

D. Temperature Sensor

The temperature sensor is also a critical sensor of the system as it is used to moderate the temperature of the room. A secondary sensor can also be placed to monitor the weather outside the house and thus be used to calculate the optimal temperature. For example, if it was a hot day the temperature indoors would need to be lower than the preset value and if it were a cold day the temperature would be set higher. The temperature and humidity sensor module being used for the proposed system are shown in Figure 5.

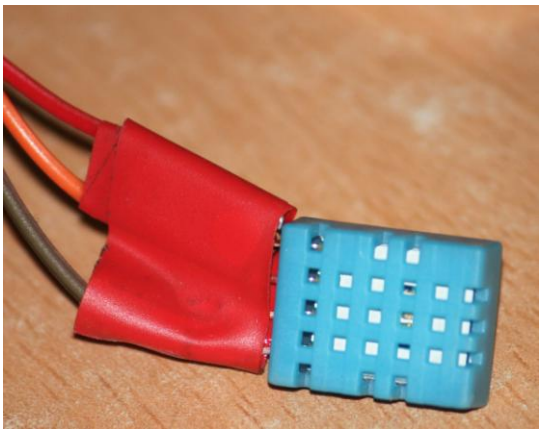


Figure 5: Raspberry Pi Temperature and Humidity sensor module.

E. Camera module

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

A common USB camera with Night vision mode was used as a camera module. OpenCV 2 was installed into the Raspberry Pi mother board to interface with the camera as needed. Thus it can be programmed to capture a video of its surrounding in order to provide image processing for the system. The camera would save a copy of the recorded video onto the system as an output file. Figure 6 below shows the camera module being used for the current system.

F.

Figure 6: USB Camera module.

Communication peripherals

The communication peripherals are built-in to the system and are used to communicate with the electronic devices provided they're compatibility with the Raspberry Pi. [6] They would be used to regulate the power input to the input devices and also be used to pass on sensor output information through multiple Smart RTOS systems provided there being more than one throughout the house hold.

IV. FABRICATION

The system is designed using the modules and components mentioned in section III. The circuit diagram is designed using Fritzing, which is a circuit design software. It clearly shows the required connections for the system. The design sketch of the system is displayed below in Figure 7.

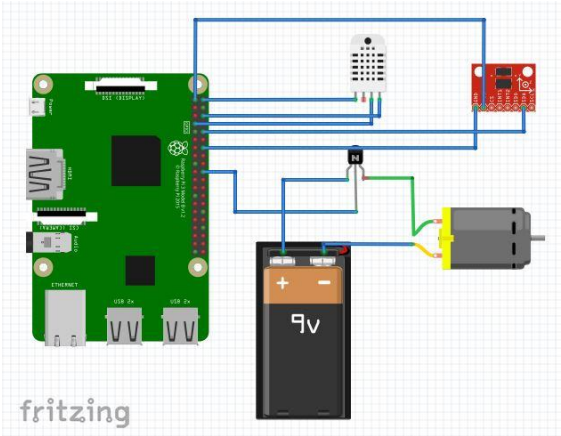


Figure 7: Circuit design of the system using Fritzing design software.

The Raspberry Pi is programmed by interfacing it with a laptop using the VNC viewer software. In order to establish a connection to interface the Raspberry Pi with the laptop, VNC server had to be downloaded and installed into the Raspberry Pi. Once installed, The Raspberry Pi is connected to a mobile hotspot with the laptop. Wireless Network Watcher is used to identify the IP address of the Raspberry Pi and the connection is made using the VNC viewer application. Doing so would thus provide access to the Raspberry Pi in order to program it. The programs for VNC viewer and Wireless Network Watcher are displayed below

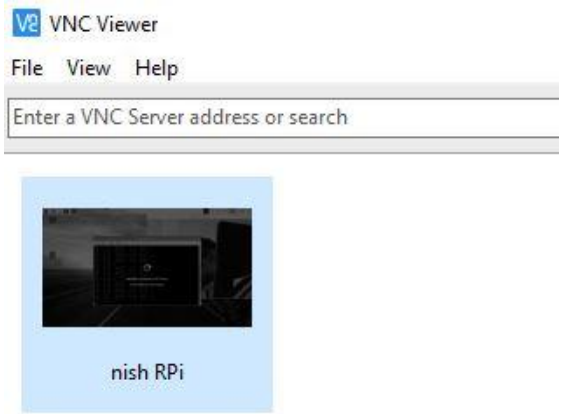


Figure 8: VNC viewer interfacing with the Raspberry Pi.

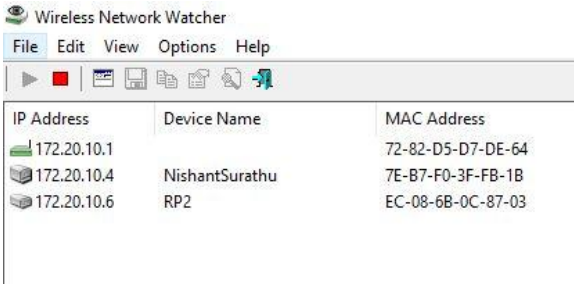
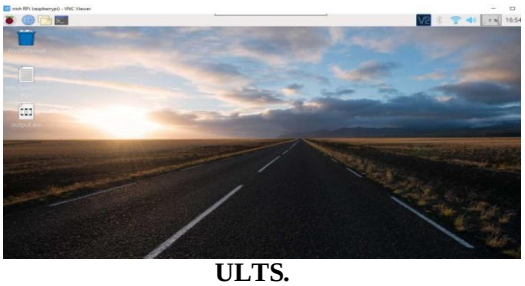


Figure 9: Wireless Network Watcher application identifying the IP address of the Raspberry Pi.

in Figures 8 and 9 respectively.

The VNC viewer is thus able to connect with the Raspberry Pi through the communications modules and thus program it to interface with the required sensors and camera. The interfacing between the laptop and the Raspberry Pi is displayed below is Figure 10.

V. RES



ULTS.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

The Raspberry Pi is successfully connected as shown in Figure 7 of Section IV. The system is interfaced to the sensors through the GPIO unit. The sensors receive their required power input from the GPIO unit and are able to send data back to the raspberry Pi. The temperature and humidity sensors are used to monitor environmental data whereas the PIR motion sensor is used to track any movement within the room. By doing so, the raspberry Pi is made to function as programmed. The figure displayed below shows the hardware set up for the proposed system.

Figure 11: The required connections for the proposed system.

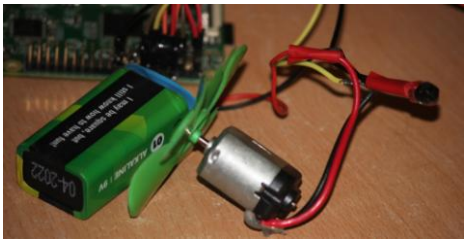


Figure 12: The BC547 transistor made to act as a switch in Common Base mode.

The system is designed to operate through the sensors in order to provide the necessary data for the RTOS system. The output is displayed to the user through the use of a BC547 transistor that is connected to a battery and a motor in common base mode and made to act as a switch. When the temperature of the environment is below the programmed value and the motion sensor is made active, The Raspberry Pi provides the transistor with the required amount of energy to make it start conducting and thus the motor is powered through the battery and turns on. The circuit connection for the motor is displayed in the figure below. Additionally, there is a LED that is made to glow when the above mentioned pre-requisites are met. The below figure shows the output of the temperature and humidity sensor while the motion sensor is passive.When the motion sensor is made active, The USB camera is made to record a 10 second video of the room in order to perform image recognition as an additional enhancement to the system. Doing so would promote a more personal service from the system to each individual user. The user's facial data would thus need to be trained into the Raspberry Pi. The figures below show the output of the system when the motion sensor is made active and the system being powered through the power bank. Additionally, the raspberry pi could be made to operate directly upon start up by accessing the .bashrc file on the Raspberry Pi's system and adding in the command to run the program automatically.

VI. DICUSSION

Electronic waste has become a very prominent problem in today's society. With the growing development of technology, past systems have become comparatively worthless and aren't being disposed of in a very efficient manner. The need to rectify this issue is growing as time goes by and as technology evolves and adapts to the growing demands of mankind. The need to recycle these systems has thus become more aware and will become crucial in the prominent years to come. Thus the development of such systems that are capable of evolving them to compete in the current market is absolutely needed. Through the development of such modifications, these systems can be made to compete with even the best of their

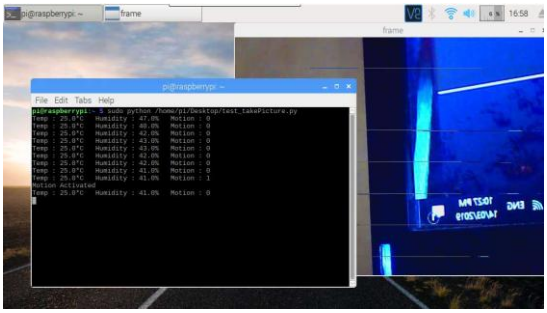


Figure 14: The output of the temperature and humidity sensor and the motion sensor when active.

current competitors very easily. But doing so requires a

Figure 15: The proposed system when connected to a power supply.

great deal of awareness of the technology that has evolved today and the nature of mankind's demands. After all, as time goes by, these requests are bound to grow to meet the future technological revolution and adapt to their demands as well. Consider an air conditioning unit from 5 years ago with no prominent built-in computing system. Such a device would be made to operate with only the goal of being able to cool down or warm up the environment it has been placed in. But equipping such a devices with the proposed smart environmental tracking system would not only enable it to compete with the growing market of smart air conditioning units but also mak

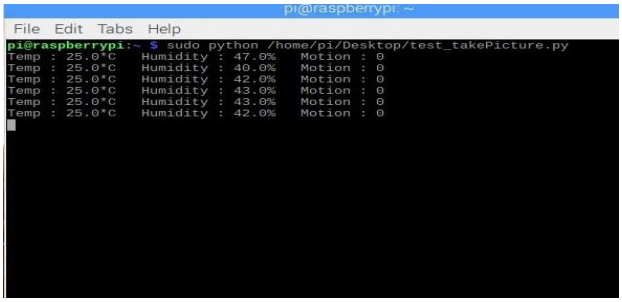


Figure 13: The output of the temperature and humidity sensor and the motion sensor when passive.

it very affordable for the user. Furthermore, it can as be made to evolve and be developed further through the addition of the necessary sensors to fit the environment it has been placed in and also regulate power to improve upon its efficiency. The need for such devices are therefore in high demand and need to be developed with the future of electronic waste recycling kept in mind.

VII. FUTURE SCOPE

The proposed system is designed to be implemented into cloud computing servers to offer better connectivity. Ensuring this would also give additional security to any of the recorded data and provide the outputs to other systems operating in the same manner without having to be physically present. Suppose the proposed system is being used at both a person's home environment and office environment, it would not be a requirement that the system would have to be re programmed to meet the user's needs. Rather if the system could be uploaded to the cloud servers it could mean that the different devices could be connected to each other to meet the same pre-set user data given to the home system or work system. The system could also be re-engineered to accommodate many more sensors or a motion detector camera using image processing techniques to offer better value and service to each and every user as intended. The capabilities of such a system are fairly inconclusive as it is made to vary as per the user's life style and needs in that particular environment.

VIII. CONCLUSION

The system can be easily fabricated to meet the demands prescribed. The system would not only be able to receive the systematic environmental inputs but also account for any variation that are to happen through time. It can also be modified and trained to recognize specific user data when a sufficient database has been initialized. Doing so however would require a great deal of natural data input, to make a sophisticated predictive algorithm that has decision making skills tailored to each user.

ACKNOWLEDGEMENT

The author would like to thanks Dr. Kirupa Ganapathy, Head of the Department of Electronics and Communications Engineering for her support and guidance through the development of this project and for her advice in making it possible.

REFERENCES

1. D. Norris, The Internet of Things: Do-it-yourself at Home Projects for Arduino, Raspberry Pi and Beaglebone Black. Tab Electronics, 2015.
2. M. Maksimovic,´ V. Vujovic,´ N. Davidovic,´ V. Milosevi˘c,´ and B. Perisi˘c,´ "Raspberry pi as internet of things hardware: performances and con-straints," design issues, vol. 3, p. 8, 2014.
3. H.-Q. Nguyen, T. T. K. Loan, B. D. Mao, and E.-N. Huh, "Low cost real-time system monitoring using raspberry pi," in Ubiquitous and Future Networks (ICUFN), 2015 Seventh International Conference on. IEEE, 2015, pp. 857–859.
4. J. M. Pearce, "Building research equipment with free, open-source hardware," Science, vol. 337, no. 6100, pp. 1303–1304, 2012.
5. F. Cuomo, E. Mibuari, K. Weldemariam, and O. Stewart, "Leveraging raspberry pi for interactive education," in Proceedings of the 4th Annual Symposium on Computing for Development. ACM, 2013, p. 16.
6. M. Richardson and S. Wallace, Getting started with raspberry PI. " O'Reilly Media, Inc.", 2012.
7. S. Jain, A. Vaibhav, and L. Goyal, "Raspberry pi based interactive home automation system through e-mail," in Optimization, Reliabilty, and Information Technology (ICROIT), 2014 International Conference on. IEEE, 2014, pp. 277–280.
8. W. Zhao, J. Jegatheesan, and S. C. Loon, "Exploring iot application using raspberry pi," International Journal of Computer Networks and Applications, vol. 2, no. 1, pp. 27–34, 2015.
9. V. Vujovic´ and M. Maksimovic,´ "Raspberry pi as a sensor web node for home automation," Computers & Electrical Engineering, vol. 44, pp. 153–171, 2015.
10. A.N. Ansari, M. Sedky, N. Sharma, and A. Tyagi, "An internet of things approach for motion detection using raspberry pi," in Intelligent Computing and Internet of Things (ICIT), 2014 International Conference on. IEEE, 2015, pp. 131–134.
11. T. Teixeira, G. Dublon, and A. Savvides, "A survey of human-sensing: Methods for detecting presence, count, location, track, and identity," ACM Computing Surveys, vol. 5, no. 1, pp. 59–69, 2010.
12. T. A. Nguyen and M. Aiello, "Energy intelligent buildings based on user activity: A survey," Energy and buildings, vol. 56, pp. 244–257, 2013.
13. Q. Hao, F. Hu, and Y. Xiao, "Multiple human tracking and identification with wireless distributed pyroelectric sensor systems," IEEE Systems Journal, vol. 3, no. 4, pp. 428–439, 2009.
14. Q. Hao, D. J. Brady, B. D. Guenther, J. B. Burchett, M. Shankar, and S. Feller, "Human tracking with wireless distributed pyroelectric sensors," IEEE Sensors Journal, vol. 6, no. 6, pp. 1683–1696, 2006.
15. M. A. Guvensan and A. G. Yavuz, "On coverage issues in directional sensor networks: A survey," Ad Hoc Networks, vol. 9, no. 7, pp. 1238– 1255, 2011.
16. S. Prasad, P. Mahalakshmi, A. J. C. Sunder, and R. Swathi, "Smart surveillance monitoring system using raspberry pi and pir sensor," Int. J. Comput. Sci. Inf. Technol, vol. 5, no. 6, pp. 7107–7109, 2014.
17. J. Lu, T. Zhang, F. Hu, and Q. Hao, "Preprocessing design in pyroelectric infrared sensor-based human-tracking system: On sensor selection and calibration," IEEE Transactions on Systems, Man, and Cybernetics: Systems, vol. 47, no. 2, pp. 263–275, 2017.
18. K. N. Ha, K. C. Lee, and S. Lee, "Development of pir sensor based indoor location detection system for smart home," in SICE-ICASE, 2006. International Joint Conference. IEEE, 2006, pp. 2162–2167.
19. Q. Hao, F. Hu, and J. Lu, "Distributed multiple human tracking with wireless binary pyroelectric infrared (pir) sensor networks," in Sensors, 2010 IEEE. IEEE, 2010, pp. 946–950.
20. M. Shankar, J. B. Burchett, Q. Hao, B. D. Guenther, and D. J. Brady, "Human-tracking systems using pyroelectric infrared detectors," Optical engineering, vol. 45, no. 10, p. 106401, 2006.
21. M. Moghavvemi and L. C. Seng, "Pyroelectric infrared sensor for intruder detection," in TENCON 2004. 2004 IEEE Region 10 Conference, vol. 500. IEEE, 2004, pp. 656–659.

22. Traversa, E., Ceramic sensors for humidity detection: The state-of-the-art and future developments, Sens. Actuators B Chem. 1995.
23. Rahman Wagiran and Mohd Nizar Hamidon Hamid Farahani, "Humidity sensors principle, mechanism, and fabrication technologies, A comprehensive review,"Sensors, 2014.

AUTHORS PROFILE

Nishant Mathew Surathu[1] is a student of Saveetha School of Engineering, SIMATS, Chennai currently pursuing a degree in the Bachelor of Engineering in Electronics and Communications Engineering. His field of interest include Applied electronics, Robotics, VLSI and Embedded systems.

T.J. Nagalakshmi[2] is an assistant professor in Saveetha School of Engineering, SIMATS, Chennai. She has completed her Bachelor of engineering degree in Electronics and Communications Engineering and her Masters degree in Applied electronics. She is currently pursuing her PhD in intrusion detection system. Her field of interest includes electronic devices, electronic circuits, VLSI design and Wireless AD-HOC networks