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Development of smart strips in the house for safety monitoring

Devyani Kadgaye [1], *Dr Rahul Chaudhari* [2], *Prof. Manish Narkhede* [3]

[1] PCCoE, Pune India
[2]PCCoE, Pune India

Abstract

Safety monitoring of residential premises has been a topic of keen interest to many researchers. Moreover, this monitoring and control are greatly facilitated these days with the advancement in wireless data transmission technology. A smart Wireless sensor network is the key to the Internet of Things (IoT) as it can detect moisture, sense fire, gas, water leakage, and seismic vibration present in the house. In the proposed work, the development of a smart strip using wireless sensor networks for health and safety monitoring in the house is done. This system uses sensors at various places inside the wall to monitor parameters including humidity moisture content, seismic vibration, and fire. The sensed data is collected using a microcontroller board and then processed and sent to the concerned people

Keywords: Safety, health and safety monitoring, wireless sensor network, smart house, esp32 board, dht22

INTRODUCTION

In recent years, many research papers have been published related to safety monitoring with the help of wireless sensor technology with their functionality. The development of wireless sensor technology is important in the evolution because it can be more useful for health and safety monitoring as it can reduce the possibility of accidents inside the house due to gas leakage, increase in temperature, water leakages, etc. Accidents may cause permanent disablement to any family member. So, a system can be developed which shall detect such types of leakage or mishappenings cause accidents. Innovative progress has recently evolved dramatically. Finding the right data anytime, anywhere today is very easy. Customers of smart devices can use these gadgets to access large amounts of data from anywhere on the Internet.

Health and safety monitoring

The process of health and safety monitoring includes the installation of sensors, data collection, analysis of data, transfer of data, and diagnostics through which the performance is monitored for the health and safety of the house. Health and safety monitoring gives valuable information such as the house's condition, enabling residents to make decisions regarding maintenance, and it can help to give surety of the safety of family members.

A sensor is used to detect and collect some type of input like light, heat, motion, moisture, pressure, or anything from the physical environment. The output is converted to a human-readable display. The WSN is used in various areas such as healthcare, residential and commercial projects occupancy information, human behavior, personal safety, and health monitoring of structures.

In the beginning, wireless sensor networks (WSN) is to be used in the industrial sector for manufacturing control, equipment monitoring, and control, and structural health monitoring. Wireless sensor networks are composed of low-power embedded sensor nodes that are connected through self-forming, self-healing wireless networks with flexible topologies.

METHADOLOGY

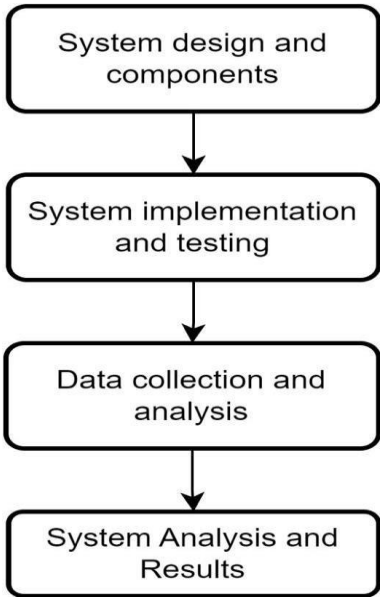


Fig. 1. *Methodology of Project*

LITERATURE SURVEY

This chapter deals with a literature survey carried out related to health and safety monitoring.
This study was all about a broad survey and analysis of relevant research articles about sensing technologies for structural health monitoring (SHM). Wireless sensors and sensor networks are emerging as sensing paradigms that the structural engineering field has begun to consider as substitutes for traditional tethered monitoring systems. (Jerome P. Lynch and Kenneth J. Loh, 2006)

Industrial health and safety monitoring system and issues which causes accidents are highlighted. In this work, they demonstrate the main relationship between organization and technology in the concrete industry accordingly they designed a system that reduces the number of accidents by using the wireless sensor for monitoring workers. Formulation of risk behavior and risk perception and rules are formed for health and safety. (Gerd Kortuem, David Alford, Linden Ball, Jerry Busby, 2007)

Hazardous gas is dangerous to health hence, improving construction safety management is important. WSN is a key technology in the Internet of Things (IoT). Building information modelling (BIM) technology is used for the digital modelling of databases and geometry that gives visualized way of the lifecycle of construction management. They developed a unique system using BIM and WSN which visually monitors construction site safety and automatically removes hazardous gas if present. (Weng-Fong Cheung, Tzu-Hsuan Lin, Yu-Cheng Lin, 2018)

The Internet of Things (IoT) application uses a sensor with the help of cloud computing. They mainly focused on health care monitoring using network sensors either worn on the body or in a living environment. Challenges and opportunities for IoT in the future of healthcare monitoring are highlighted. (Moeen Hassanalieragh, Alex Page, Tolga Toyota, Gaurav Sharma, Mehmet Aktas, 2015)

They introduce IoT-based indoor safety monitoring for COVID-19 parameters like sensing temperature without contact, mask detection, and social distancing check. They used raspberry Pi. In this research, they used MQTT (Message queuing telemetry transport) the machine-to-machine communication between devices like Raspberry Pi, Arduino and smartphones. (Nenad Petrovic, 2020)

Portable healthcare monitoring systems in hospitals are designed using IoT technology which is the process of healthcare from face-to-face consulting to telemedicine. The system is used to monitor the patient's basic health simultaneously room condition is also monitored. They were using five sensor heartbeat sensor, body temperature sensor, room temperature sensor, CO sensor and Co2 sensor to capture the data and data is conveyed by portal to medical staff accordingly they can analyze the patients' current situation. (Md. Milon Islam, Ashikur Rahaman, Md. Rashedul Islam, 2020)

Low-cost wireless sensors are used for the development of civil infrastructure systems. Methods of structural health monitoring for bridges and buildings. Wireless monitoring with their prototypes and embedded data processing are discussed in detail with the help of case studies. (R A Swartz and J P Lynch)

The methods are discussed to detect, locate, and damage detection of structural and deck systems using measured vibration. Various criteria are developed such as level of damage detection, model non-based methods and linear and non-linear methods. Damage identification methods are classified at different levels. They also used the unity check method, and stiffness error matrix method and their effects and changes. (Scott W. Doubling, Charles R. Farrar and Michael B. Prime, 1998)

Monitoring based on the sensor LRFD designed Girder Bridge. They analyzed lightweight bridge decks on star city bridge in Morgantown. They used a total of 700 sensors which can record superstructure elements to various loading parameters and record data every 20 minutes which can continuously monitor data and evaluation of the performance of the bridge since construction in 2003-2004. (Samir N. Shoukry, Mourad Y. Riad, Gergis W. William, 2009)

Health monitoring based on the IoT can provide remote monitoring of patient health to doctors to access the data. This system is low power consumption, is cost-effective and has access to doctors for collecting information about the patient health that can help doctors to monitor the patients easily. This system is cost-effective, can be accessed from anywhere via the internet and is time-saving in critical conditions. (Zia Uddin Ahmed, Mohammad Golam Mortuza, Mohammed Jashim Uddin, Md. Humayun Kabir, Md. Mahiuddin, Md. Jiabul Hoque, 2018)

Indoor air quality is important for the health and safety of passengers everywhere. This study is related control and monitoring of IAQ in subway stations with the help of WSN. They suggested the framework was designed to monitor IAQ and used twisted pair local network, Zigbee wireless network to collect and transmission of data. This system is used for safety in subway stations to increase the efficiency and productivity of operations. (Gi Heung Choi and Joo Hyoung Jang, 2021)

Worker safety is a very major problem in the construction industry. Fall detection and monitoring of their health are proposed to ensure the safety of the worker system. This system overcomes all issues and injuries of the worker. It can provide alert the responsible person to provide medical attention. (K.M. Mehata, S.K.Shankar, Karthikeyan N, Nandhinee K, Robin Hedwig P.)

Structural health monitoring can also be monitored with the help of a wireless sensor network is discussed in this research paper based on ZigBee Technology. ZigBee technology is used for structural health monitoring of buildings bridges and roads and analysis is done with the help of multi-hop network technology is used for effective time synchronization. (Xiang-dong JIANG, Yu- Liang TANG, Ying LEI)

Smart home and a smart city which is very popular in this generation. The smart home concept includes video monitoring of apartments or separate waste bins with the help of an internet network. They introduced Augmented Reality, Smart City and Smart Home technologies which can save time,

and improve the security and quality of life of people. (Zhmud V., Liapidevskiy A., Roth H., Nosek J., 2019)

DEVELOPMENT SYSTEM DESIGN

Operations

A system should be developed to monitor parameters like gas leakages, shock and vibration, and fire detection that cause accidents in the house with the help of a wireless sensor network. The sensor gets the information from the surroundings data sensing is done and after sensing the data the transmission is to be done with the help of cloud computing data analysis is done.

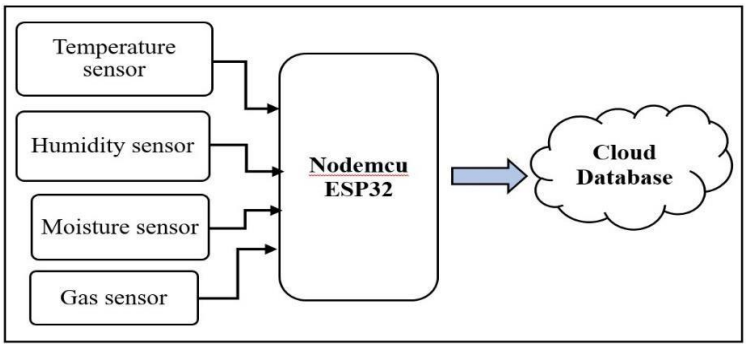


Fig. 2. *Block Diagram for the System*

Major Components Used in smart strip

The following components are used to develop a system:

1. ESP32 development board
2. DHT22
3. Moisture sensor

ESP32 development board

ESP32 is a development board for WIFI and Bluetooth IoT-based applications. This board chip has a Tensilica Xtensa LX6 microprocessor in both dual and single-core variations. It has a 240 MHz clock rate.

Functions

1. ESP32 has many applications in IoT but it is mainly used for networking, data processing, P2P connectivity and web servers.
2. In the networking module, a WIFI antenna and dual-core enable embedded devices and then connect to routers and it can transmit data.
3. Data processing deals with the basic input from an analog and digital sensor for critical calculations with a real-time operating system (RTOS).
4. P2P connectivity directly makes communication between the ESP board and other devices.

Applications

ESP32 is used for the following devices

1. It can use in Industrial devices with programmable logic controllers.
2. Medical devices include monitoring of health.

3. It can use in Energy devices like HVAC and thermostats.
4. It can use for Security devices including surveillance cameras and smart locks and monitoring for security purposes.

DHT22

DHT22 is a low-cost humidity and temperature sensor which has a microcontroller of 8-bit which gives output values of humidity and temperature properly. It is a more accurate sensor and it can work in a higher range of temperature and humidity

Table. 1. *DHT22 Sensor Module*

Sr. No.	Pins	Description
1	Vcc	Power supply 3.5V to 5.5V
2	Data	Outputs both Temperature and Humidity through serial Data
3	Ground	Connected to the ground of the circuit

DHT22 Specifications:

1. Operating Voltage: 3.5V to 5.5V
2. Operating current: 0.3mA (measuring) 60uA (standby)
3. Output: Serial data
4. Temperature Range: -40°C to 80°C
5. Humidity Range: 0% to 100%
6. Resolution: Temperature and Humidity both are 16-bit
7. Accuracy: ±0.5°C and ±1%

Applications:

1. It can Measure temperature and Humidity.
2. It can help local weather station and automatic control can be done.
3. Environment Monitoring can be done.

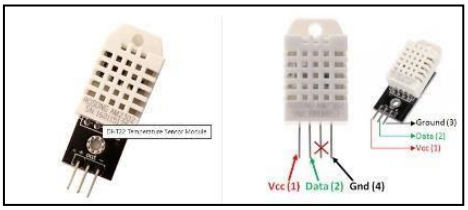


Fig. 3. *DHT22 sensor module with pin-out*

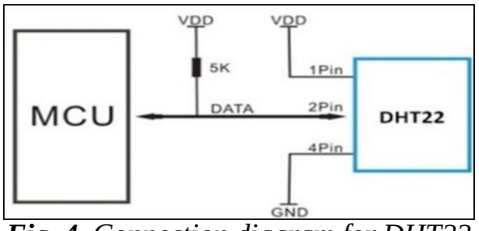


Fig. 4. *Connection diagram for DHT22*

Moisture Sensor

A moisture sensor is used for the detection of the amount of moisture present in the wall. This sensor measures the volumetric content of water inside

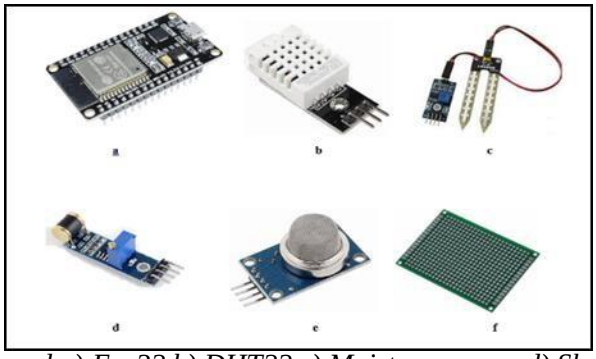


Fig. 5. *Components used a) Esp32 b) DHT22 c) Moisture sensor d) Shock sensor e) Gas sensor f) PCB board*

Thinkspeak

Thinkspeak is an IoT-based cloud platform that sends data from sensors to the cloud. It can analyse and visualize all collected data with MATLAB or any other software, including making its application. It is used for real-time data collection and data processing. Channels are used for data storage, each channel includes 8 fields for any type of data, 3 location fields, and 1 status field.
In this smart strip.

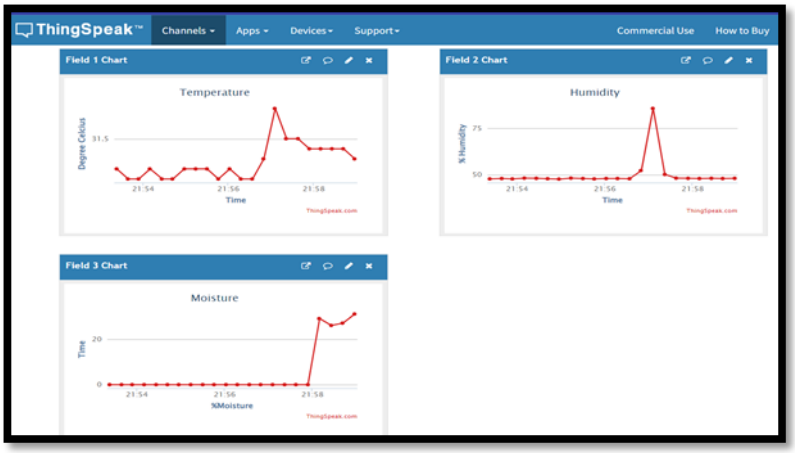


Fig. 6. *Graphical representation of data collection*

Moisture meter

We are using the Stanley moisture meter model 0-77-030. It detects moisture in wood and common building materials including drywall, plaster, concrete and cement board.

Specifications:

1 Display: LCD with dual measuring scale
2 Wood range: 6-44%

3 Building material: 0.2-2.0%
4 Temperature: 32F-104F
5 Operating Humidity: 80% max relative humidity
6 Battery: 1.5 volt

Fig. 7. *Moisture meter*

Data Collection

Data collection is done from various sites from the college and hostel. A smart strip is put where moisture is to be measured. After that connect the mobile hotspot and Real-time data collection is started. Data can be exported and imported through think-speak software.

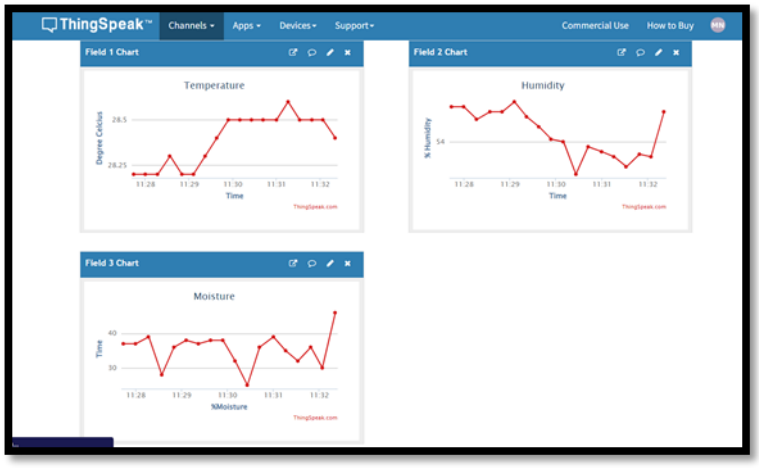
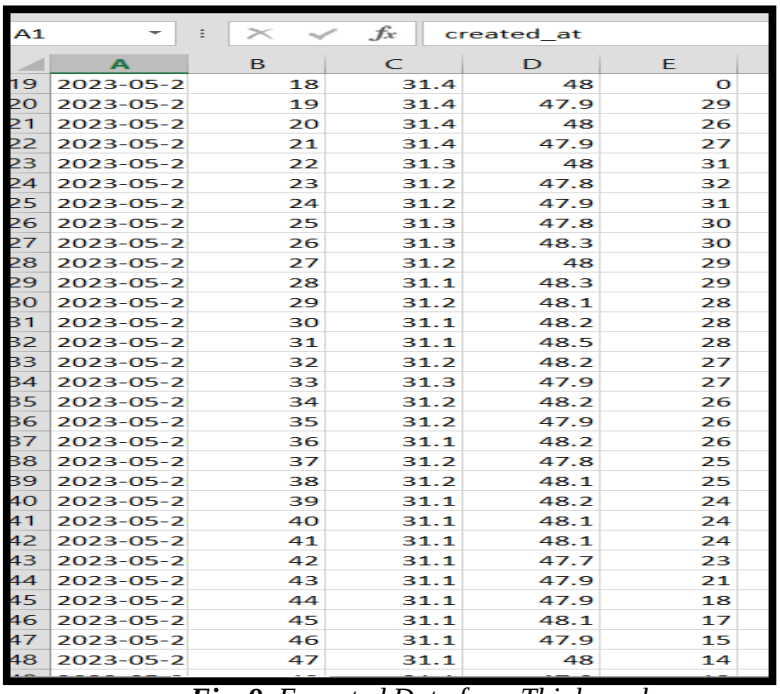


Fig. 8. *Graphical representation of temperature, humidity and moisture.*



A1 created_at

	A	B	C	D	E
19	2023-05-2	18	31.4	48	0
20	2023-05-2	19	31.4	47.9	29
21	2023-05-2	20	31.4	48	26
22	2023-05-2	21	31.4	47.9	27
23	2023-05-2	22	31.3	48	31
24	2023-05-2	23	31.2	47.8	32
25	2023-05-2	24	31.2	47.9	31
26	2023-05-2	25	31.3	47.8	30
27	2023-05-2	26	31.3	48.3	30
28	2023-05-2	27	31.2	48	29
29	2023-05-2	28	31.1	48.3	29
30	2023-05-2	29	31.2	48.1	28
31	2023-05-2	30	31.1	48.2	28
32	2023-05-2	31	31.1	48.5	28
33	2023-05-2	32	31.2	48.2	27
34	2023-05-2	33	31.3	47.9	27
35	2023-05-2	34	31.2	48.2	26
36	2023-05-2	35	31.2	47.9	26
37	2023-05-2	36	31.1	48.2	26
38	2023-05-2	37	31.2	47.8	25
39	2023-05-2	38	31.2	48.1	25
40	2023-05-2	39	31.1	48.2	24
41	2023-05-2	40	31.1	48.1	24
42	2023-05-2	41	31.1	48.1	24
43	2023-05-2	42	31.1	47.7	23
44	2023-05-2	43	31.1	47.9	21
45	2023-05-2	44	31.1	47.9	18
46	2023-05-2	45	31.1	48.1	17
47	2023-05-2	46	31.1	47.9	15
48	2023-05-2	47	31.1	48	14

Fig. 9. *Exported Data from Thinkspeak*

CONCLUSION

In this paper, we reviewed the current state and projected future directions for integration of remote health monitoring technologies into device like smart strip.From the study conducted it can be mentioned that the IoT Based Sensors are the way to reduce the error and accident on construction industry. It can reduce and Increase the productivity. Health and safety monitoring can detect accidents caused and it reduce the accident rate. By installing smart strips in the house moisture, temperature and humidity in the surroundings can be identified, and it can give real-time moisture readings hence, health and safety monitoring is important.

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