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IOT BASED ENVIRONMENTAL PARAMETERS MONITORING SYSTEM FOR A CONTAINER

POOJYA DODDAPPA COLLEGE OF ENGINEERING GULBARGA

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Name of the students:

PRAJWAL RATHOD (3PD18EC053)

PREMKUMAR P DHAGE (3PD18EC054)

ROHAN Y BISNAL (3PD18EC062)

ROHIT N CHAVAN (3PD18EC064)

UNDER THE GUIDANCE OF:

Asst. Prof. PANKAJ MAHOORKAR

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

ABSTRACT

Internet of Things (IoTs) interconnects physical devices and objects to offer services to improve user's experience. For instance, empowering traditional transport system with IoT will provide greater visibility and traceability to control and monitor objects remotely. In traditional transportation systems, containers carrying groceries and beverages should be sealed carefully, kept below a certain temperature, and should be placed in a physical safe place to minimize chances of damaging owing to jerking and accidental falling. During a container's shipping, it continuously monitors temperature, humidity, location, and analysis it on remote cloud server to notify the stakeholders when a certain condition or violation occurs.

Keywords*— Internet of Things (IoT), Supply Chain, Container monitoring , MQTT.*

INTRODUCTION

Containers mainly transport the imported and exported commodities. Almost 89% of the world trade is accomplished with the help of containers and they can be used in different means of transportation, including ships and trains [1]. Container transportation is characterized by high efficiency, convenience, and safety, and has an important position and role in modern transportation systems. However, Environmental variations that are adverse to the quality may be occurred in the transporting procedure. Therefore, it is important to monitor the status of the container to maintain the quality of transported goods. The state of fruit, vegetables, dairy products transported in the container should be monitored to guaranty the quality maintenance. The temperature variations and humidity variations may affect the quality of the transported goods. The work focus on distributed measurement of temperature and humidity for a container to provide the information about the container during transportation [2].The wired sensors may represent a good solution but the connectivity faults can appear during the loading and unloading of container. Wireless sensor network may be considered a reliable solution. Thus, the wireless sensor nodes may help us continuously measure or monitor the humidity and temperature of the container. The data delivered by WSN (Wireless Sensor Network) nodes are stored using a remote database that is part of a cloud service .The data analysis results are presented on the user interface in real-time. In this paper is presented an IoT (Internet of Thing) system for container parameters monitoring based on WSN nodes. The WSN nodes provide the inside temperature, humidity and also provide the real-time container tracking using GPS (Global Positioning System) receiver. The temperature and humidity values together and time and co-ordinates values are delivered from sensors.

PROBLEM DEFINITION

This project proposes a monitoring and tracking system to keep customers updated about his purchased item by providing information detailing the condition of the environment that the item is being transported in, regardless of the transportation method, until item is delivered. The proposed solution is smart, cheap, and secured.

- Developing an automated monitoring system that will measure the conditions of the environment inside the container and alert the user in case of certain violations or events.
- Employing a technological solution for transmitting telemetry data from the container to a Cloud Based Server; where, it is analyzed and sent to the users.
- Developing an application for accessing or receiving information about the current status of the container and its position from the cloud server.

I. BLOCK DIAGRAM

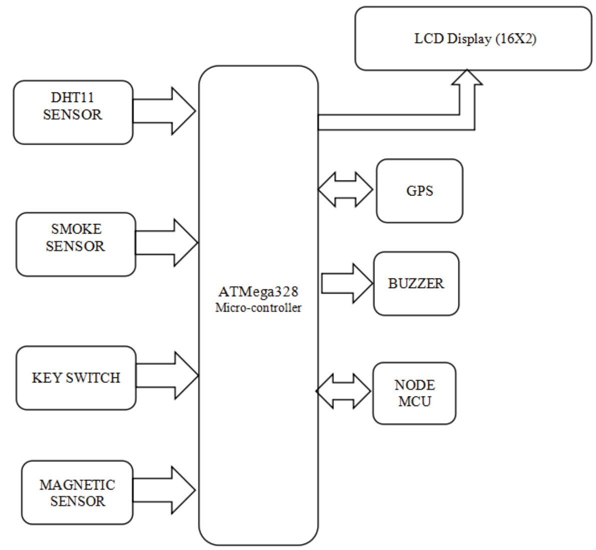


Fig No.1 Block diagram of ATMega328 Micro-controller

The block diagram consists of several types of sensors that are use for monitoring and tracking of the container. The DHT11 sensor is used to monitor the temperature and humidity of the container and this values are displayed on the LCD display and as well as on the IOT platform. And for tacking of the container we use a GPS module which provides as the latitude and the longitude values of a container. The buzzer is used for providing the fire alarm and also when unauthorized person tries to open the door of the container. For uploading the data to the IOT platform we use a NODE MCU module. In this project we use an open source IOT platform i.e. Adafruit platform.

LITERATURE SURVEY

The IoT system for container was researched for monitoring and tracking it. In this project a continuous monitoring of temperature was made, with levels of alarm if the product had a problem. In [3], the container logistics monitoring system that combines WSN and GPRS was introduced. Authors in [4] proposed a solution for constructing a communication network for stacked containers by deploying communication nodes on the surface of containers to form a customized wireless sensor network .An application of wireless sensor network that is dedicated to monitoring temperature-sensitive cold chain products was proposed in [5]. In [6], a wireless sensor module and the network, based on the IEEE 802.15.4 standard, for logistics container temperature monitoring was proposed. Authors in [7] proposed a container monitoring system based on wireless sensor networks.

METHODOLOGY

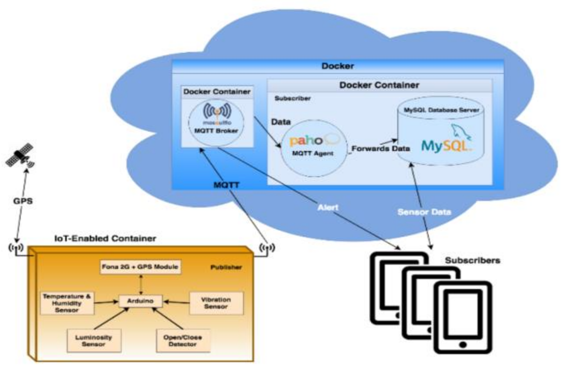


Fig no.2: System Architecture of Container

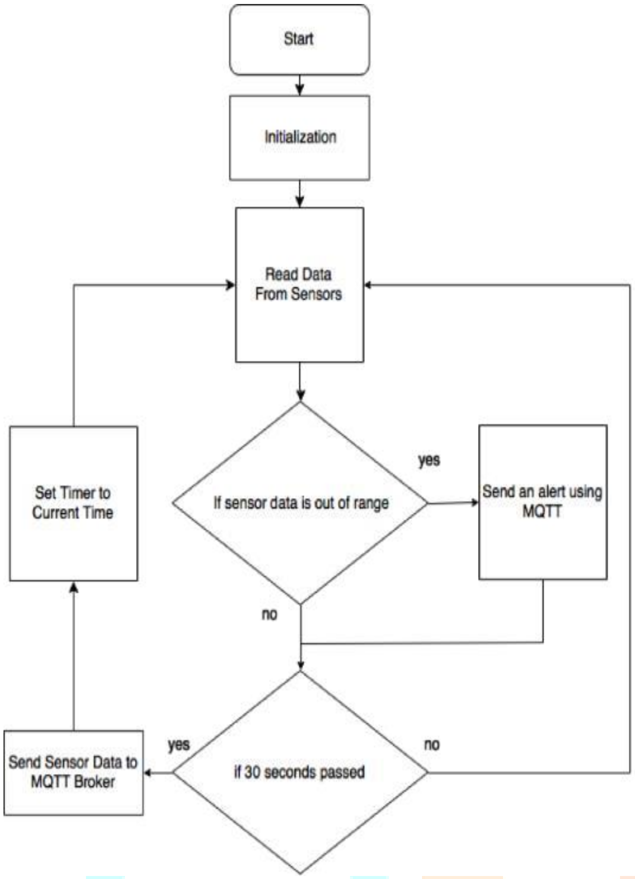
This section presents the system overview, design, and implementation details. The specification of the smart container is to monitor the temperature, humidity, light exposure and sudden, strong vibrations and shocks that the container might be subjected to. It monitors the container's integrity, as it should not be opened before reaching its destination. It also keeps track the current where about of the system using a GPS tracker. All of this information is sent to an IOT on a cloud-based remote server via Adafruit IO, where all the data is processed and stored. Then, the data is displayed for users through the use of a mobile application and mobile notifications for subscribers of the Adafruit IO service. The system architecture is shown in Fig. 2.

The Arduino Uno uses the Fona's 2G connection in order to establish a connection to Adafruit IO Cloud using the MQTT protocol and publish the telemetry data to it. In the Cloud, the broker forwards the published data to the subscribers. Since the database is in a separate Container from the broker, a python-based MQTT agent called Paho is used to receive the published data by subscribing to the topic. Then, it processes the published data and then inserts it into the appropriate table in the MySQL database. The history of the data and the alerts issues are stored in the database and can be accessed at any time via the mobile application. The database contains two tables; one stores the history of published sensor data, and the other stores all the alerts that were issues. All published data contain a timestamp and the location of the container, for accountability purpose.

A. ARDUINO CONTROL FLOWCHART

Fig. 3 presents the control flow within the Arduino based on our algorithm.

Above fig 3 shows the features or the requirements that the mobile application must adhere to. As can be seen in Fig. 10, there are two cases upon which information is published; In case a sensor detects an abnormality. Additionally, every 30 seconds, it will publish a batch of telemetry data, which it reads from all the sensors, to the MQTT broker.



B. IMPLEMENTATION DETAILS AND SYSTEM VIEW:

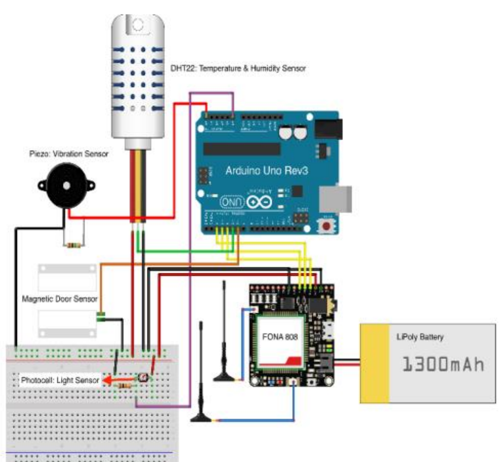


Fig no. 4: Overview of Smart Container's Circuit Diagram

This section discusses the implementation details. The implementation methodology of the system is divided into three phases. The first phase is related to the hardware components of the system such as circuit design .The second phase is setting up the server in the Amazon cloud and setting up the connection to the hardware. The last part is concerned to the development of mobile phone and testing it. The designed circuit is based on set of multiple datasheets of the components. The proposed algorithm is implemented in Arduino. The antennas are placed outside of the container, so that the material does not affect the signal, and the sensors are placed in the compartment in which commodities are placed. The boards used are placed in a hidden and sealed compartment to avoid tempering. In the second phase, the Amazon Cloud server was setup with the appropriate containers using Containers. We have setup two containers; a container on which the MQTT Broker was installed, and another where the MySQL database was installed. In order to communicate with each other, a python-based agent was implemented in the database container which acts as an MQTT client that receives the published data, processes it, and inserts it into the appropriate tables in the database.

The database was designed with two tables, one to store all the records of the telemetry data sent periodically, and another table which stores the history of the alerts sent by the publisher. After setting up the server, the communications become possible between the Smart Container hardware components and the Cloud-based server. We used an MQTT library provided by Adafruit (The developers of the FONA 808 GSM + GPS breakout board that we are using to track the container as well as connect to the cellular network) to connect to the server and publish the telemetry data. The snippets show the implementation of the code using the Arduino IDE. The smart container with closed mode is presented and it encompasses temperature, humidity, and security based sensors to ensure safety of items in containers during shipping. The container is manufactured based on the specifications as discussed above. The antennas are placed outside of the container, so that the material does not affect the signal, and the sensors are placed in the compartment in which commodities are placed. The boards used are placed in a hidden, sealed compartment, so as not to be tampered with. For initial testing, the container was attached to laptop server via a serial USB cable. The container sends data using attached antenna to the cloud.

CONCLUSION

The emergence of IoT technology has created opportunities for containers housing perishable fresh foods while avoiding risk of accidental damages. In traditional transportation system, to ship perishable fresh foods across the cities/countries, the food items got affected owing to the changes in environmental conditions. For this problem, IoT based container system is a competent solution. A fully functional hardware and software architecture, design, implementation, and working prototype of a container system that demonstrate all the capabilities and features of the system are presented. It has proposed a dashboard (accessible via mobile devices or web browsers) for configuration, user interaction, and real-time monitoring of containers. It integrates sensory data of shipping containers with the overall cloud-based system to automatically push alerts and notifications to stakeholders when certain conditions or violations occur. The proposed system has been implemented and tested in the field to validate its correct functioning. To extend this work, Block chain can be introduced to the project, to ensure that all alerts sent are immutable, and that the transportation company cannot escape its responsibilities by denying the integrity of the alerts. Moreover, local storage for overseas shipments where cellular coverage does not exist could be added to the implementation. Finally, to reduce the cost of the hardware, customized function-specific chips could be used instead of the multi-purpose boards currently used, which boast unused features.

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