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A SMART WAREHOUSE INVENTORY MANAGEMENT AND MONITORING SYSTEM USING INTERNET OF THINGS AND OPEN SOURCE TECHNOLOGY

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Abstract: In the present era, managing the inventory is crucial part in the industries. More man work and time is taken for managing products in the inventory. So this paper deals with a smart inventory management system that diminishes the man work and makes the process done in a smarter way. The IoT technology integrated with open source technology enhances the performance, security of the system. In this system with the help of RFID technology, the products are annexed with RFID tags and scanned by the RFID reader. The Arduino mega with ESP8266-01 gathers the data from the products and updates the data into the web server. This system automatically checks the count of products in the inventory, if the count is less the system automatically orders the products. Some sensors such as DHT11, MQ2 and fire sensors are used for monitoring the environmental parameters in the inventory and takes necessary actions if needed. The GSM module notifies the users with the updated messages regarding the products. The gathered data in the web server is monitored with real time scenarios in the Android app by Internet of things.

Keywords: **IoT, RFID, Smart Inventory, Sensors.**

I. INTRODUCTION

The location identification system is employed with many applications where the location of object or personnel is significant. Smart systems play a key role in industries, households, colleges and other native environments. The concept of localization is growing linearly in smart systems, because location plays a crucial role in contemporary life. Placing any particular object accurately is truly challenging. IoT is a vision that allows for the association of individuals and things in a perfect world using any path or any service.

The portion that stores items or products are called the Warehouse. Warehousing cites the activities involved in storing goods on an enormous scale in a precise manner and ensuring their availability whenever possible [1]. The need for a warehouse to store different kinds of products or commodities in order to sustain seasonal production, seasonal demand, fast supply, continuous production, price stabilization. For every warehouse the warehouse inventory management program is a necessary approach. There may be several zones in Warehouse, and those zones are often called Stockrooms. The desire to automate warehouses stems from the fact that manual handling systems can lead to human errors which can affect the operation of t he warehouse.

Identification process is based on AIDC (Automatic Identification and Data Capturing). The AIDC technology has its own relevance among the numerous available technologies. The typical AIDC technology is Barcode technology which is used for reading labels by optical scanners. Barcodes Is an immense advance over normal text labels because it is no longer essential for the staff to enter data manually into the system [2]. The RFID technology replaces Barcode scanning as barcode scanners are cost intensive and protection is lower. When the label does harm the data cannot be read by the scanner. The RFID tags have more data storage capability than the Barcode.

With the help of electromagnetic spectrum the radio waves in the RFID are engage in the application automatic identification which enables the system to recognize or identify the objects that are adhered with the tags. In the indoor environment RFID technology has its own impact in identifying people or assets [3]. Whenever administrators want to find the location of an object in big companies within a precise amount of time this technology suits to be the best. The implementation of location identification system is very reliable, simple, and low cost. In the RFID system the tags are robust and are flexible that is they can be easily attached to any object.

Many standards are used by the identification mechanism but the international standardization is doing some sort of research in the field of tracking goods in the inventory management. The EPC, electronic product code technology proposed a standard

whereby they can use their own bar codes [4]. By proposing the RFID technology the market share has been eventually raised and is expected to rule the market in the upcoming years in terms of profit.

For this study secondary data has been collected. From the website of KSE the monthly stock prices for the sample firms are obtained from Jan 2010 to Dec 2014. And from the website of SBP the data for the macroeconomic variables are collected for the period of five years. The time series monthly data is collected on stock prices for sample firms and relative macroeconomic variables for the period of 5 years. The data collection period is ranging from January 2010 to Dec 2014. Monthly prices of KSE -100 Index is taken from yahoo finance.

II. PROBLEM STATEMENT

In big companies in identifying or locating any objects or products is still confronted. It is still a challenging to find any product, asset or person in a mobile restricted area within a precise scope of time. By adopting the Radio frequency technologies the above circumstances will be eliminated. The RFID technology enables the tracking of products, goods and people in the indoor environment. By working with RFID system, the users can experience fast response time, power efficient, reasonable.

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III. LITERATURE SURVEY

A location identification system affords relative facts approximately the region of personnel or items, identification, tracking and tracking of people or belongings in a actual Real time. Numerous programs which include area identification of employees and property in hospitals, large offices or institutions and identification of tagged objects in warehouses can employ this machine which will acquire correct localization results. In massive institutions or workplaces, there might be masses and thousands of humans working each day moving from one region to the other [5]. These days, localization is gaining a lot of publicity. The use is used in applications for monitoring and tracking. Localization is simply called target identification unknown node for communication performance. Using GPS in sensor node is the simplest way to achieve localization. It results in high accuracy for indoor applications and cannot be appreciated for indoor positioning due to poor indoor system impact of GPS. The addition of GPS to all nodes further increases the cost of the entire network, which is not desirable. In indoor positioning applications, ultra wide band technologies are used effectively [6]. It's like an affinity focused on ALOHA to get by exchanging location information. But they're not economical and involve a large setup that isn't a factor want. Later, several algorithms of localization came in to the picture to extract the location information. There is a greater prevalence of Scope free and Scope based algorithms among them. Range Based algorithms rely on calculations of distance. Two signals originate from a single node in TDOA, and are obtained by the aim (unknown node). The distance value refers to the time differential between those two signals. It provides high precision, but requires additional hardware resulting in cost and complexity.

3.1 Global Positioning System

Moving to the point of outdoor environments, the GPS (Global Positioning Sy stem) is well suited for tracking objects, but this device is not suitable for monitoring or locating objects in indoor environments as GPS is not always suitable due to its reduced precision and poor reception of satellite signal for indoor environments indicators. It is a satellite based navigation structure confined up to 24 satellites. In the 1980's the US government primly thought of testing the GPS in the military applications. The GPS satellites pirouette over the earth consummate an orbit. The GPS devices have the adequacy to compute the location and commutate the satellites. For manipulating the precise locality of the GPS device, the GPS satellite employs the trilateral algorithm. The position of mislaid object is constructed on a virtual map based on the latitudes and longitude position. The GPS satellite after the decisive the locality of the device can determine the speed, trip distance, track the time to destination [7]. The GPS satellite and GPS device are capable of carrying three category of information they are the pseudorandom code, ephemeris data, almanac data. Localization efficiency of the GPS system decreases if ensured signal intensity is impartial with the device being deployed. The dominant application of the Global Positioning System is in warehouse terrain, military etc.

3.2 Inertia Navigation System

This Navigation Inertia (INS) system is also used for outdoor localization.Sensors are the instruments that sense a signal, and then report the received signal to the machine. The INS system doesn't need any exclusive hardware. The INS system is conjointly called as inertial measurement units and inertial guidance system. This system is elementarily developed for the rocket. The gyroscopes, accelerometers are the tools used for manipulating the objects position. For apprehending the data or related information from the objects initially three accelerometers, gyroscopes are used. The systems are restricted due to their high cost, the system is also unreliable and the range for this system is limited to just 300 meters [8]. With the advancements made in the micro electromechanical systems the in systems are structured to small size. The Inertia navigation system has the capability of calculating variation in velocity, change in orientation. The gyroscope and accelerometer tracks the initial position of the object by the utilization of angular velocity and angular acceleration. This system suffers from the minute faults in the computation of angular velocity and acceleration.

3.3 Bluetooth

The Bluetooth signifies the standards analogous to wireless personal area network. The prime goal of Bluetooth is to associate devices within a precise scope of network. The personal area network is powerful, mobile. For associating with the devices, Bluetooth employs an encryption and authentication for the pairing process. In the process of pairing, the block cipher is suggested with a pair of keys [9]. The Bluetooth has a read range feature, so it can range from 1m/10m/50 m. Bluetooth costs jump if more range is required. But there are a number of 7 slaves. This system, but this system is not ideal for locating objects.

3.4 Infra Red laser

The IR laser functions in the spectrum of light with an invisible wavelength. The IR laser operates in the midst of near and far infrared regions. Due to the invisibility characteristic this system is applied in the domains of market, military. The IR lasers in the domain of military are used to track the targets, target acquisition, surveillance. This is a high precision capturing system that allows supervising of diverse sensors concurrently. This system has an accuracy of 0.1mm. In this system the transmitter transmits the infrared signals. A few limitations has been found in this system they are the influence of light sources, a field of 50 meters is only achieved by the manufacturer.

3.5 Infrared systems

The infrared systems work on the fundamentals of infrared radiation. It has longer wavelength but it is invisible. William Herschel is the preeminent person for the invention of invisible light in the spectrum band. By the change in the rotational and vibration motion of particles the infrared is emitted. Medical, scientific, industries are some of the major pertinence. Due to the IR performance and reluctance of radar lead to the involvement of IR application in defense, The Infrared system having efficiency range of 5-10 meters. This is low- priced, compact, low power consumption system. The low range IR sensors may not function up to long ranges and are susceptible to light interference. In bad weather conditions this system must be capable of providing alternative methodologies. In working scenarios they are sensitive to sunlight, these also require an acceptable line of sight for the devices to get communicated [10].

3.6 Camera and Laser Indoor positioning system

The principle target of the CLIPS is posture estimation of a portable camera as for a stationary projector on a tripod stand. In the reference field a set of red color laser is framed in the domiciliary environments. When the set of field is captured by camera the statistical association among the camera pretense and projectors can be recognized by co planarity outcome. This system works only for 2D positions, to work for 3D positions the scaling value must be known.

3.7 Radio Frequency Identification

In the Identification and control systems the RFID technology seems to be the appropriate technology followed by researchers. Among the distinct available technologies the RFID has its own importance in the domain of supply chain management. By adopting the RFID technology in the sphere of Supply chain will reduce the contingency in industries, effective working of warehousing, tracking of materials is done efficiently, eliminates the theft of materials The RFID tags integrated with the electronic product code yields in good results. The electronic product code enhances the performance and facilitates to uniquely identify objects or goods with the RFID tags. In the supply chain this EPC is used to identify the materials or product in the supply chains [11]. The Electronic product code global network enables to interchange information among many users in a network. RFID is the outstanding technology to implement in composition to achieve the desired consequences. The RFID technology eliminates the need of barcode because the RFID does not necessitate any line of sight, every tag has a Unique Number, allowing instantaneous reading, durable in nature, and huge amount of data is stocked.

IV. INTERNET OF THINGS ELEMENTS

Internet of Things considers the following elements such as Identification, sensing, communication, computation, semantics and services [12].

4.1 Identification

For IoT systems the recognition plays a significant role. The accessible forms of identification are the universal and electronic product codes. Many of the addressing approaches used in IoT include the IPv4 and IPv6. The current methods of identification are not special globally, and it is possible to mark objects individually by using addressing.

4.2 Sensing

Sensing in the internet of things allows physical devices or sensors to capture and upload data from the devices in the network into the cloud. The sensors like actuators, smart sensors can be used in the Internet of Things.

4.3 Communication

For delivering specific smart services the communication technologies enables the physical objects to communicate with each other. The IoT nodes may consume more power if the communication links are noisy and loose. The machine to machine concept was first realized by using the RFID technology. The RFID reader and the tags get communicated with the help of electromagnetic waves. The NFC, Bluetooth, LTE, Wi-Fi, UWB are some of the alternatives in the communication technology.

4.4 Computation

The software applications combined with the processing units signifies the ability of computation in IoT. Many IoT applications are developed based on hardware platforms as the Arduino, Raspberry Pi, ARM, Beagle Bone, and UDOO. For providing Internet of Things functionalities the software platforms are used. Many real-time operating systems are available in the market, but Contiki RTOS has been most adapted for the Internet of Things applications. The cloud platform also serves as one of the computation units in IoT-based applications. The cloud platform enables the smart objects to senses the data and big data performs some analysis on them and provide the data to the users.

4.5 Semantics

In the Internet of Things, semantics enables the ability to extract data from distinct machines and then facilitate required service. The aspects of recognizing and analysis of data enable them make decisions.

4.6 Services

There is four types of services employed by the Internet of Things are linked to identity, aggregation of information, Collaborative awareness, Ubiquitous services. The services related to identification are the significant services they have the ability to uniquely identify each item. Data processing systems take steps to process the data collected and transfer the data

generated to the applications for IoT. The collaborative services carry out the decision making process and respond in Real time. The Ubiquitous services aim at providing users with the data at anytime and everywhere

V. SYSTEM IMPLEMENTATION METHODOLOGY

The developed inventory management and monitoring system depicted in the Fig.1 is built on the architecture of IOT. The open source hardware Arduino mega 2560and ESP8266-01 plays a vital role in the developed system. The innovated system deals with both countable and uncountable items. This system consists of two parts management and monitoring. In the monitoring part sensors such as DHT11, Fire sensor, Gas sensors are used.

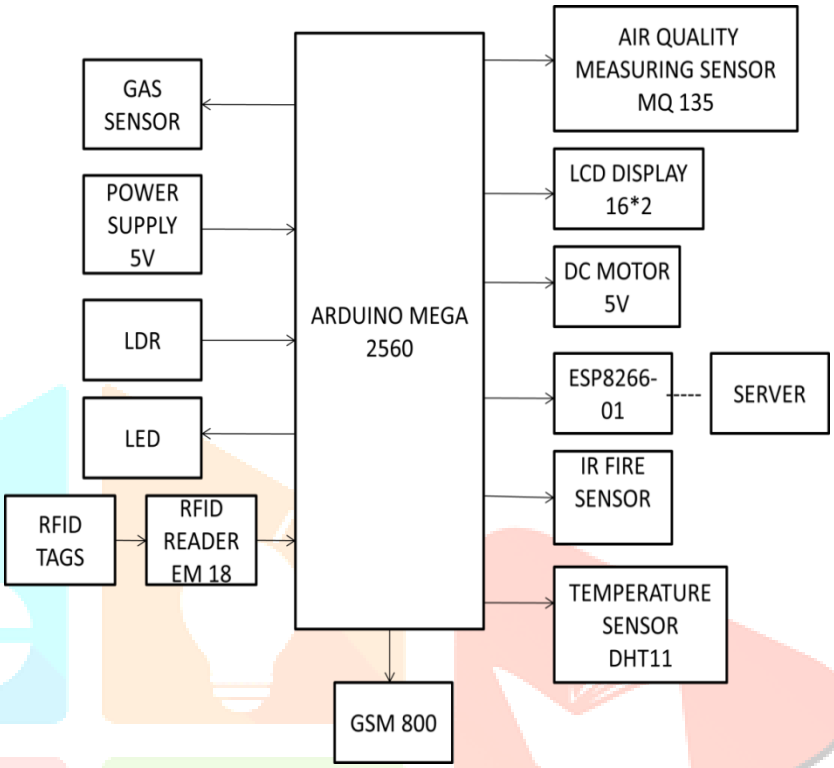

Fig.1. Block diagram of the Implemented system

In the management part RFID tags, Reader, LDR, LED, are used. The ESP8266-01 provides internet facility o the Arduino Mega. The products are attached with RFID tags. The RFID reader EM18 scan the tags and updates the information in to the thing speak server using the ESP 8266-01 module. In case of the products count becomes less than the required count then the system alerts the user via GSM as the product count is less. The uncountable things are managed by combination of LDR and LED. When the light from the LED does not fall on the LDR then it indicates that the uncountable items are up to the specified mark or limit. If the light from the LED falls on the LDR then it indicates that the specified uncountable items are not up to the limit. Then that information from monitoring system via GSM and notifies that the item is less in quantity. The same information is also updated in the thing speak server. The Inventory Management system is established on the wireless communication between the Reader and the central server through Wi-Fi. The RFID system comprises a reader and tag unit. The RFID reader transmits and receives the signals from the tags. The RFID tags adhere to the objects or products. The reader, whose function is to interrogate tags, consists of an RF module that transmits and receives radio frequency signals. Each reader has a certain range of operation and so the reader and the tag have no need to be in the line of sight. It can read the tag as long as it is in the scope of the reader. Every tag has a unique ID or serial number which makes it easy to identify and locate every individual among several others in a unique way. The system will be more useful in mobile prohibited areas. With the help of the oscillator present in the RF module can create or impose carrier frequencies and an amplifier for making the signal strong and that signal must be detected by the tag. The demodulator and amplifier are again present in the received module so as to receive the data and also to build up the received signal. The sensor such as DHT11, Fire sensor, Gas sensor measures the temperature, Humidity, fire detection and abnormal gases detection in the inventory environment. If the sensors detect any abnormal conditions a fan will be ON. All the data from the Inventory management and monitoring will be visualized in an android app developed via thing viewer and MTI app inventor.

VI. RESULTS AND DISCUSSION

The Fig.2 sculpts the hardware formulation of the Warehouse Inventory management and monitoring system.
The Warehouse Inventory management and monitoring system contemplates both the management and monitoring in the warehouse.

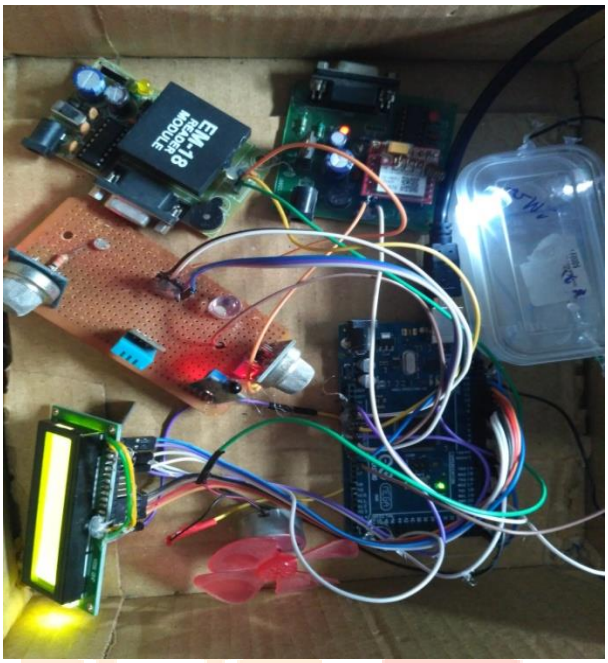

Fig.2. Hardware of the Implemented System

The Fig.3 depicts the outcome in the developed Android app, the product 1 entitles the field for countable products. The Number 5 in the product 1 field specifies that there are only 5 products remained in the countable products.
The product 2 entitles the field for uncountable products. The Number 460 in the product 2 field specifies the remained quantity in the uncountable products.

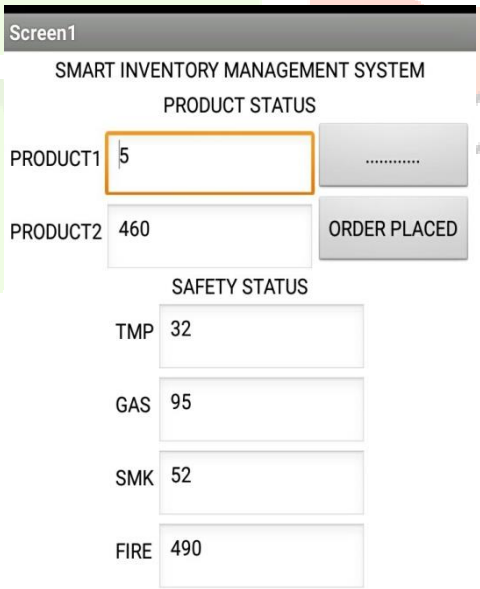

Fig.3. Products and Sensors data in Android App

The TMP, GAS, SMK, FIRE fields in the Android app eludes the accumulated temperature, gas, smoke and fire sensor values. In the TMP field, the value 32 specifies the deliberated temperature value in the Warehouse inventory. . In the GAS field, the value 95 specifies the deliberated gas value in the Warehouse inventory. In the SMK field, the value 52 specifies the deliberated smoke value in the Warehouse inventory. In the FIRE field, the value 490 specifies the deliberated fire value in the Warehouse inventory

The Fig.4 depicts the SMS imparted by the GSM module when the countable products quantity is beneath 3.

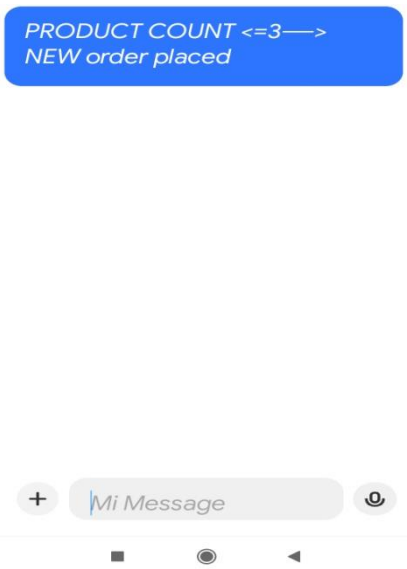

Fig.4. SMS received for countable products.

The Fig.5 depicts the SMS imparted by the GSM module when the uncountable products quantity is beneath.

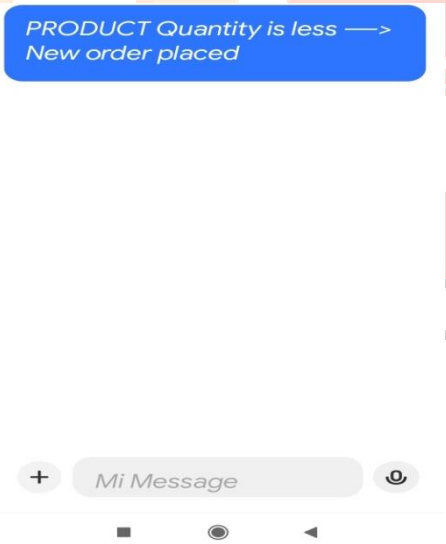

Fig.5.SMS received for uncountable products

VII. CONCLUSION

The developed warehouse inventory management and monitoring system can perform dynamic data update. With the aid of Android App the innovated system manages and monitors all the entities in the warehouse. In the future, this system will be used in various applications in many fields, and several changes can be made to make it accessible to all sectors. The information given by the system, about the products in the warehouse would increase the efficiency and effectiveness of the system. Care should be taken that the tags are not lost and are always with the respective products. This system can serve as a web server and can give access to the data over the web.

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