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Intelligent Packaging System: An IoT Solution for the E-Commerce Industry

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Abstract- Ecommerce, also known as electronic commerce refers to the buying and selling of various goods andservices online. In the recent days the word "Ecommerce "has become very familiar due to the internetboom and due to the kind of comfort (and other services) it provides to its users. Many companies haveeither established their business or have increased their profits with the help of Ecommerce. There arevarious studies which show that there is an exponential increase in the Ecommerce sales and services and it is very much evident that it will reach new heights in the upcoming years.
Ecommerce businesses has seen a 265% growth rate, from $1.3 trillion in 2014 to $4.9 trillion in 2021also higher. With such a mass boom in Ecommerce people don't prefer to buy goods offline since they receive more benefits by buying online. But unfortunately, there are a few problems that both the company and its customers are facing. And gradually such problems have been increasing and major issues were with regard to the faulty delivery system. To handle such situations, we propose a solution to avoid any delivery related problems that are caused during delivery and to put a stop to such problems by making sure every customer gets the products as it is by the dealer directly without any interference while delivering. This report discusses about the part of IoT in secured packaging solution,the proposed approach.

I. INTRODUCTION

Overview

The Intelligent Packaging solution aims to use an electronic packaging solution to combat the problem of opening packages during transportation as well as to measure the characteristics of the product, the inner and outer atmosphere of the package. The project IPS aims to use electronic packaging solutions to effectively trigger an alert when a package is opened. This is done by using many sensors in a failsafe system. The problem with single sensor-based systems is that they do notcorrelate data from different means. IPS uses many sensors that continuously track the physical parameters inside the package to ascertain if the package has been opened or there has been some rise in temperature (for pharmaceutical and temperature sensitive products). Once this alert has been sent to those concerned, they can take necessary action. If there is no alert and a normal delivery takes place, the customer uses his/her mobile phone to scan a QR code displayed on the IPS kit. Thiswill result in an OTP that is received at the customer's mobile and entering the OTP with the kit willreset the device. The IPS kit is then removed from the box and given to the delivery executiveto be reused again. Internet of thing (IoT) is not only an interesting research topic but also a booming industrial trend. Although the basic idea is to bring things or objects into the web, there are various approaches because an IoT system is highly application oriented. Some problems that always arise within the packaging of products are difficulty and inaccuracy in determining appropriate packaging options according to type and condition of the product to be packaged. Incorrect decision of packaging option can cause loss in quality, physical damage to product, packed products might get spoilt, especially perishable and time sensitive products. The smart locker may be a modular and expandable solution developed especially for parcel collection. The functionality are often managed locally.

Security of knowledge is of primary concern and therefore the system is fully compliant with all dataprotection standards. No resident data is stored locally thanks to the enterprise level cloud-based control system. With the rise of ecommerce, there is an Intelligent packaging solution increasing need to manage online purchase deliveries effectively. Now here is this more apparent than within apartment complexes nationwide.

Today, Internet is migrating from connecting people to connecting things, leading to the new conceptof Internet of thing (IoT). This new trend brings things or objects into the Internet and generates new applications and business. It is predicted that 212 billion devices are going to be installed by 2020. These things, ranging from indoor wearable devices to outdoor environmental sensors, became newsources generating data on Internet, together making the entities on Internet more aware of the real world. This brings new applications or revolutions in many fields such as transportation, healthcare, home, industrial, agriculture automation freshnessand extend shelf life during the distribution process (Yam et al, 2005).

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Packaging design that combines elements and design guidelines are oriented to the environment, also play a crucial role in informing and directing consumers to keep buying. The increasing packaging types and options nowadays also necessitates more systematic andprecise thanks to select the simplest packaging option for a certain type of product. Decision making processes are often faced with a good range of unique conditions, uncertain, dynamic, time consuming and sophisticated nature.

II. PROBLEM STATEMENT

Definition Increased customer experience expectations and product complexity are driving traditional packaging techniques obsolete. In addition to this, traditional packaging methods do not provide the customer as well as the manufacturer with important information about the product during shipping Figure 1 shows delivery mishandling & Figure 2 shows damaged product received.



Figure 1 Delivery executive mishandling goods



Figure 2. Damaged laptop delivered

To overcome this, we need to develop an intelligent packaging system that uses the Internet of Things and Machine Learning for authenticating, securing, and tracking high value packages Figure 3 shows replacement of actual product with soap bar.



Figure 3 Delivery mishaps

III. OBJECTIVES

1) To Design a kit that is able to detect any kind of intrusion in its space.
2) To integrate a kit to give information about all the necessary parameters of the environment whenthe product is kept inside the package.
3) To alert everyone who is in charge of the delivery cycle of the product.

4) To include a reset at the end of the delivery cycle and be reusable on the next instance.
5) To develop a kit using Node Mc module to verify the authentication of the customer

IV. HARDWARE & SOFTWARE REQUIREMENTS

A. *Hardware Requirements*

1) ARM
2) IR sensor
3) LDR sensor
4) LCD
5) DC motor
6) Power supply
7) MEMS
8) Keypad(4x4)
9) GPS
10) WIFI(ESP8266)

B. *Software Requirements*

1) Embedded C language
2) Aurdino IDE
3) Telegram Bots

V. WORKING

A. *Methodology*

1) The project aims to use electronic packaging solutions to effectively trigger an alert when a packageis opened.
2) This design has many sensors that continuously track the physical parameters inside the package toascertain if the package has been opened or there has been some rise in temperature (for pharmaceutical and temperature-sensitive products).
3) Once this alert has been sent to those concerned, they can take necessary action.
4) This will result in an OTP that is received at the customer's mobile and entering the OTP with the kit will reset the device. 1st factor of authentication is OTP matching, so user will enter the OTP they receive through the app, onto to the keypad. This OTP will be matched with the OTP being generated by the microcontroller.
5) The IPS kit is then removed from the box and given to the delivery executive to be reused again.

B. *System Flow*

The IPS development kit will be made into a compact space and placed inside the package that is tobe secured. The package will have enough space for the kit to work properly. The sensors that are used in the IPS development kit will be turned on and will start working. The kit will travel within the box till the destination where it will be removed after verification of the data. Fig 4 shows System flow diagram.

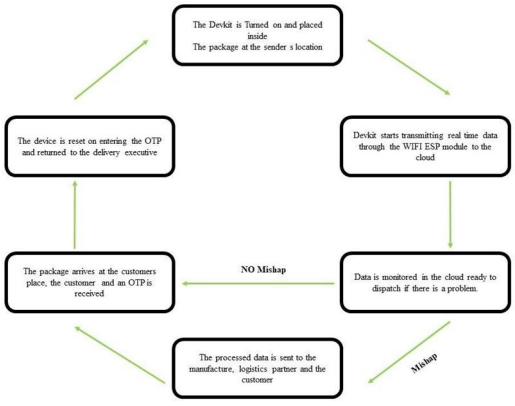


Figure 4 System flow

C. Flowchart And Description

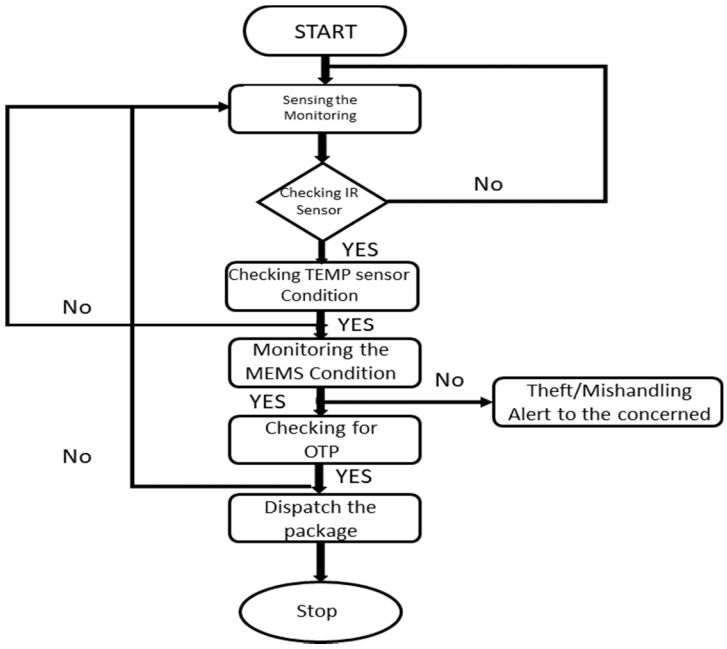


Figure 5 flowchart

1) *Step 1:* The IPS development kit is first placed in the package that is to be tracked. This is placed inside the package along with the contents of the package. This is considered very easy as it is assimple as just placing the IPS development kit along with the package to be secured. For the kit to work properly and without any interruptions it must be placed as close to the package contentsas possible. In the case of any food products or any hazardous chemicals that are beingtransported, the food products may be enclosed in another layer of packaging to protect its integrity. If the package is transporting any electronic cargo, there will be no problem in the placement of the package as there will be no electrical or electronic interference with the module.The sender must place the kit in such a way that the kit is not moving on its own inside the box. Once the kit is securely placed and it is tested for its sturdiness, the package that is containing theIPS development kit as well as the shipping contents can be sealed and locked. The IPS development kit is enabled. Fig 5 shows the Flow chart.
2) *Step 2:* The IPS development kit starts running the program that is coded into it and hence starts transmitting data to the cloud. The data on the cloud is visible on the web interface that has beenbuilt for this specific purpose. The website updates in real-time to show the change in data if anyto the parties concerned. This allows them to take any immediate action that may be necessary toensure the integrity of the package.
3) *Step 3:* The data is monitored in real-time on the cloud as well as in the IPS development kit. In the event if a mishap occurs: If there are any changes in the data that suggest a break in the integrity of the package if there is any mishap with respect to the package then an alert is sent tothe manufacturer of the product (the sender), the logistics partner (the person shipping the parcel) as well as the customer (the person receiving the parcel). This enables them to take any action that is necessary to either stop the package in transit or to verify its integrity. If there is no mishapduring transit: If there is no mishap in the entire duration that the package is being shipped, thenthe package arrives safely at the destination and no alert is raised to inform all the concerned parties. The customer scans a QR code that is present on the IPS development kit and the customerreceives an OTP.
4) *Step 4:* On receiving the OTP, the IPS development kit is reset and it is ready to be taken back bythe shipping company and installed on another parcel and the cycle of the IPS development kit continues.

D. Algorithm

1) Initially switch on the Dev-Kit
2) Check and verify if all the sensors are working and monitor the sensors data in real time using cloud technology
3) Check if IR sensor is working. If yes move on to check TEMP sensor condition and update the data on cloud, if no enter the loop to check for the sensors working again

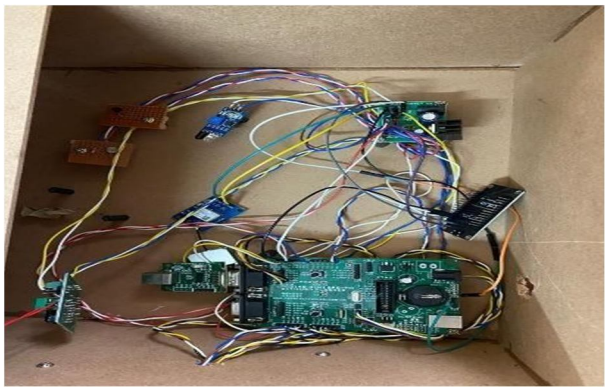
4) Next move on to check for the TEMP sensor Sensor condition, if yes and its working move on to check MEMS Sensor condition and update the data of TEMP sensor sensor on cloud, if No goback to the process of sensing and monitoring and check the working of sensors again.
5) Next move on to check the working of MEMS sensor if yes move on to check for OTP and update the data on the cloud, if no alert the ecommerce owner for theft or mishandling of the product.
6) Next check for OTP and send the OTP to the customer's cellular device and ask him to enter theOTP on the Dev-Kit keypad.
7) Dispatch the package and switch off the Dev-Kit.
8) Take the Dev-Kit back for reuse.

E. Result

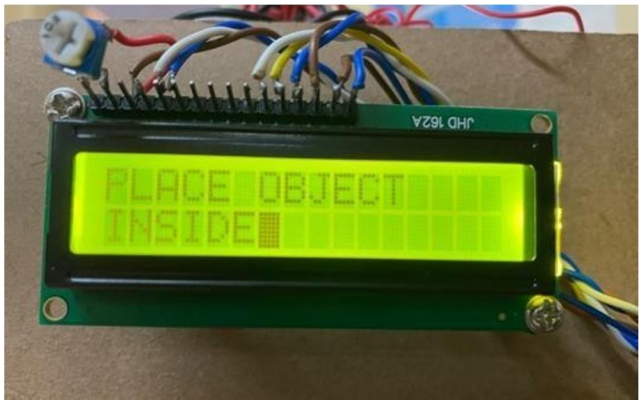
The below Figures show the working of the IPS System at each stage andalso the updates recieved in the telegram simultaneously.



Picture of the model



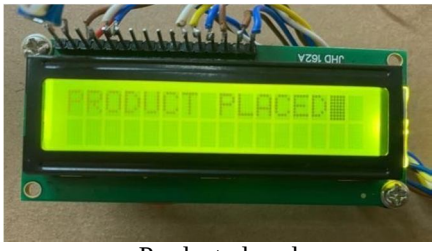
Components inside the model



Product to be placed



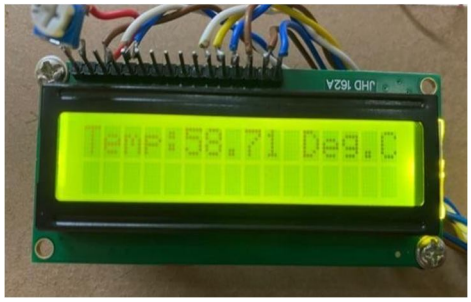
Lid is closing



Product placed



X & Y axis of the MEMS sensors



Temperature Sensor Readings



Waiting for OTP



Updates received on Telegram

VI. APPLICATIONS

IPS DevKit can be used in many industries that may transport expensive that may require utmost security. Some of them are:

1) Pharmaceutical Industries
2) Food Industries
3) Electronic Industries etc.

The idea of IPS kit with few modifications can be used to provide safety for belongings and to notifythe owner if there is any harm, damage or misplacement. IPS as a solution can be deployed in the logistics industry based on the needs of the client and targeted products.

VII. ADVANTAGES

1) Traceability/Supply chain management of the product will be easier and handy.
2) Products can be saved from getting damaged or being cloned.
3) Company's market reputation won't be harmed.
4) Minimum Human Intervention
5) Reusable.
6) Tamper proof delivery

VIII. FUTURE SCOPE

Below Feature can be added

1) Digital nameplate
2) Online administration
3) Multiple deliveries: Multiple parcels can be delivered each day by different service providers totallywithout delivery delays.
4) Time-saving: Saves time as no need for unnecessary trips to parcel collection offices.
5) Fast availability: No waiting times at goods collection points and no time lost due to shipping.

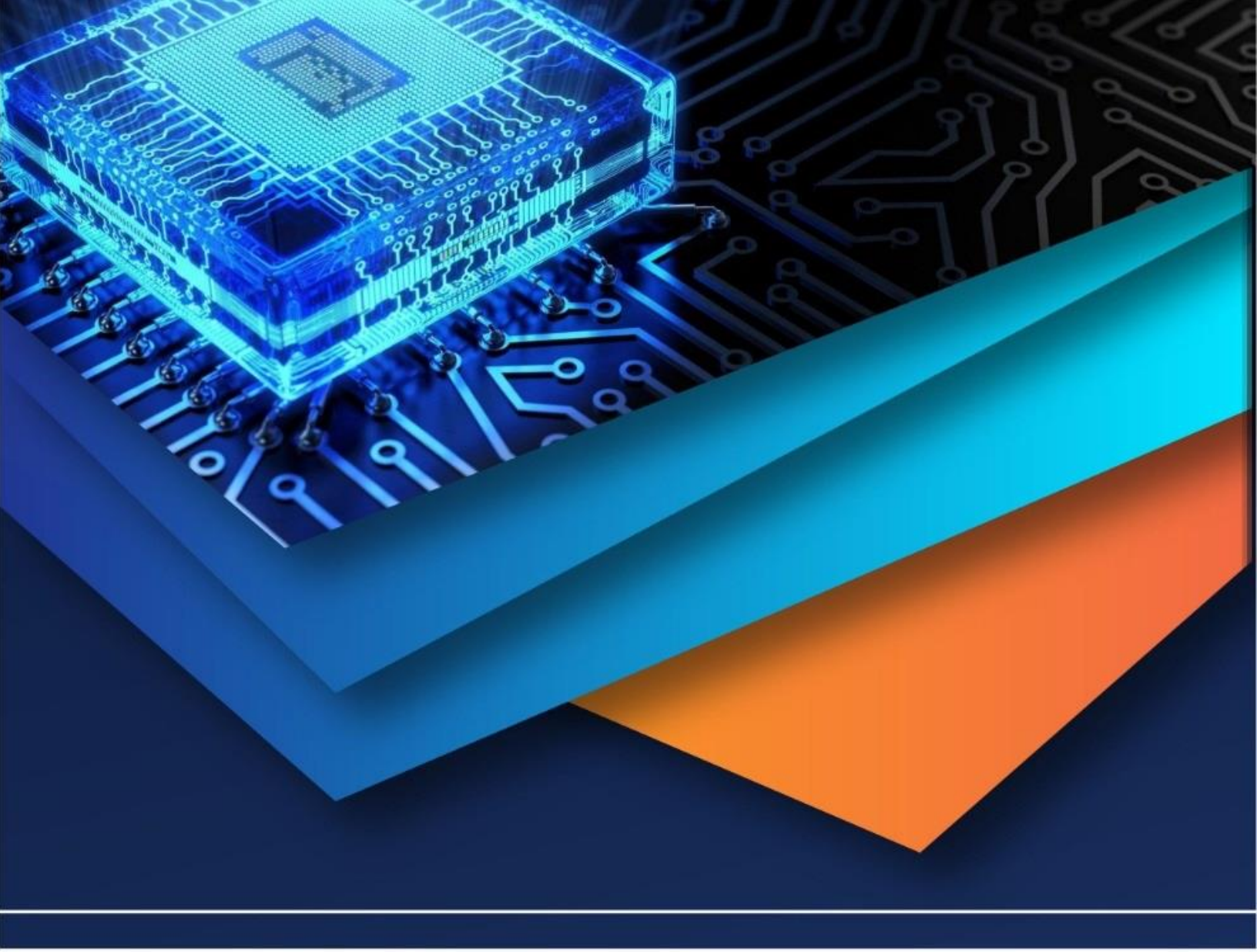
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IX. CONCLUSION

We are designing and implementing the non-destructive package testing and verification solution using an electronic packaging solution called IPS development kit. The kit will be placed inside the package with enough space to work properly. The kit will travel within the box till the destination where it will be removed after the delivery If there is any tampering or intrusion during the delivery process an alert will be sent. By this we are maintaining the integrity of the product as well as the reputation of the companies that use this system and along with that, we are hoping to ensure customer satisfaction by getting them the product they requested without any problem. In the project phase 1 we have understood the hardware requirements and the methodology to implement them andintegrate them to the ARM microcontroller. We will be using different kind of sensors and gaining knowledge about them and hence has given a different perspective on what else can be done using these sensors. We will be learning embedded C language in order to write the code for the working of the Dev-Kit. This will help us in future as we gain knowledge on how to write code.

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