Review on Intelligent Packaging Solution for Safe and Secured Delivery

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Abstract: Ecommerce, also known as electronic commerce refers to the buying and selling of various goods and services online. In the recent days the word “Ecommerce” has become very familiar due to the internet boom and due to the kind of comfort (and other services) it provides to its users. Many companies have either established their business or have increased their profits with the help of Ecommerce. There are various 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 2021 also 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.

Keywords: Packaging, Microcontroller, Node MCU, GPS/GSM, Sensors

I. INTRODUCTION

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 not correlate 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. 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. The IPS kit is then removed from the box and given to the delivery executive to be reused again. Internet of thing (IoT) isn’t only a stimulating research topic but also a booming industrial trend. Although the essential idea is to bring things or objects online so that it will be available to all, there are various approaches because an IoT system is very application oriented. Some problems that arise with the packaging of products are difficulty and inaccuracy in determining appropriate packaging solutions consistent with type and condition of the merchandise to be packed. 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 magnetic lock could be a more practical and cost-efficient solution developed especially for parcel delivery. The functionality is often managed locally. Security of data may be a primary concern and thus the system is fully compliant with all data protection standards. No resident data is stored locally thanks to the enterprise level cloud-based

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control system. With the rise of e-commerce, 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.

II. BLOCK DIAGRAM DESCRIPTION

The IPS development kit makes use of a wide variety of sensors and the brain of the kit is the Arduino Uno. The various sensors being used are DTH sensor, LDR, GPS, MEMS sensor, IR sensor and also, we will make use of various modules like keyboard, LCD, GSM, NODE MCU.

![Figure 1: Block Diagram](image)

Fig 1 shows the block diagram description of the model, LCD Display used to display each operation. LDR is nothing but a Light Dependent resistor, it is able to detect light when the kit is opened without the OTP or if the kit is not closed properly while packing. MEMS sensor is a low-cost inertia sensor, which is used to determine whether the IPS box has been mishandled or if any thief attempted. IR sensor is an Infrared Sensor which is used to detect the presence of the package and is also able to sense any kind of intrusion. The GPS is used to get the live location of the kit and this live location is sent to the user via a text message with the help the GSM module. DHT sensor is used to track the temperature and humidity inside the kit, this will be very helpful while transporting (or delivering) any food or pharmaceuticals. The core Arduino Uno is responsible for integrating all these sensors and for opening and the closing of the magnetic lock.

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III. LITERATURE SURVEY

Ge Wang et al [1] proposed a packaging system called Verifiable Smart Packaging with Passive RFID. In general the courier packages after someone orders it online goes through packaging process and later is shipped to the customer, Their primary job is to identify and track the items from the time it is been taken out for delivery till its delivered but what happens between getting out for delivery and reaching to the customer is not accounted, An intruder can replace the items in the box and no one would even notice which is a eventual loss to the customer, So to avoid such malicious events verifying and testing of whether its safe inside in other words its authenticity is necessary, In this paper a system is introduced using Passive RF tags, This is used to check the internal health of the package and to develop a non-destructible package and called it as Echoscope. There are various ways of checking whether the inside of package is intact like Ultrasonic scanning, X-Rays but these machines neither are cheaper or mobile so what Echoscope does is it extracts backscattering signal from the package to check the status of the package. This first checks once in shipping phase and later before the package is delivered to the customer and checks any difference if none the package is delivered to the customer. Echoscope is low cost and advanced compared to other testing methods.

Jiu Wen et al [2] designed a Map-Matching Service system for better trajectory of the couriers. Everyday there are thousands of online orders are to be delivered to different locations and these generate tons of data about the courier trajectory but it generally doesn’t account for various factors and with a single approach the data is sent through to the courier delivery workers and also to the customers about the estimated arrival of the package. For this Map match plays an important part in developing trajectories, the existing map matching either considers car as a mean of transportation.
or ignores it completely considering a single estimated time based on distance therefore the accuracy of such map matching trajectories is on the lower par and cannot be guaranteed. To have a better accuracy and solve this problem this paper has proposed to use a better map matching trajectory where wide range of factors should be considered. The basic problem which map-matching faces is the “Fragmentation” problem because of the fact that couriers have to deliver the packages at different locations. Car’s positioning system is based on GPs which is more reliable compared to the courier services who use wi-fi location system as there positioning system and Not everyone delivers in a Car, Most of them deliver in an electric bike or walk which are slower than the car but can cut through narrow roads and avoid comparatively more traffic, these all factors creates highly irregular trajectories which were previously ignored in existing map-matching trajectories, But now after accounting for the factors mentioned above plus some more, the new map matching called Courier trajectory based map-matching is more reliable and accurate with low time and space complexity with low latency.

SaipunidzamMahamad et al [3] Proposed a new interface for the users who are primarily trading on E-commerce field. In brief the trade happening on the online websites involves ‘delivery’ of the goods to the consumers in the given time period .This duration and quotation for a particular courier product will be generated by the delivery service company that are tied up with the specific company, a setback that is being faced in this process is that the pricing information are usually hidden and this leads to mishap and customer itself are supposed to call the or visit the website to gather the information. So overall this process highly time consuming and to overcome this they are proposed this concept of which the objective is to integrate different courier company’s services along with their service price all at one stop. This helps the consumer to analyse most cost-efficient service and peer to peer service in delivering a parcel. This project is a mobile application that will be able to bring out the quotes of several courier companies wherein customer will be able to compare the pricing of each courier company and can opt for the most efficient one. with Parcel2Go mobile application the inconvenience for the consumer and also the unrelenting issue that are present in the current courier companies. However, our concept overcomes this minor setback, as on when our project is implemented in real time will lead mass production of this model and it can be clearly quoted with pricing and customer will be given a clear picture of the delivery process, also the inflexibility of the courier can be easily solved without implementation.

Turban E et al [4]Marimin & Maghfiroh N proposed that the development and implementation of decision support system (DSS) can used to improve the process of delivery. This is done by choosing the best packing option for the product. The DSS uses previous data to teach itself and hence choose the best option available. This not only improves the whole delivery cycle but also makes it more smooth and cost efficient. The DSS application mainly focuses on the user and the delivery agency. When the customer or the agency authority login to the DSS using their credentials, they can use various functions or services to improve their experience. It makes use of the GPS at the delivery end, figures out the best route for delivering the package with the help of machine learning. At the same time, the courier can update the logistics status and immediately update it to the user through communication network. Although this method does not make use of any hardware components, it is heavy in software and it cannot be implemented in remote or rural places as it requires a strong internet connectivity to function.

Skowron-Grabowska et al [5] proposed the system of using RFID technologies instead of other means like barcode. Barcode is although a bit cheaper but is also much slower compared to RFID and cannot process large amount of data at once that’s why using RFID in Couriers has been a big revolution in past decade, RFID is 10x more efficient and unlike barcode where a person has to manually use it for the verification, RFID is completely automated and it does not require any human work to use it. The market in the current world is changing day-by-day, so the courier firm needs more efficient and optimal solutions of this ever changing courier firms where growth is necessary, these help is better management and handling of the data in courier firms, RFID performs various operations like tracking, verification, handling, managing efficiently, RFID consists of RF tags(radio frequency tags) one at the receiver end and other at the courier servicing end and it sends signals back and forth using these RF tags within a given range. The courier industry has started to adapt RFID and also exploring more option to compete and be more efficient in the domain.
Joe Bianco et al [6] proposed a package anti-theft system that looks after the delivery package as a whole and its security. In today’s world online ordering is a normal thing. Everyone orders through online applications since they get a lot of varieties plus they don’t have to get out of there home due to this large supply chain of deliveries there are some negative impacts like stealing the package when the shipment is out for delivery to prevent this, In this paper the author has discussed about how they can use weighing sensor, camera and alarm to avoid such unfortunate events, first when the delivery is about to ship the weight is checked using a pressure sensor, later if the weight of the package changes after a certain threshold the alarm starts to buzz and intimate the company, A motion detection sensor is used to check if someone apart from the delivery worker gets near to the package and the motion detection is done using PIR sensor and it can also click pictures of the suspicious person who can later be questioned. This system is a step towards improvement compared to other systems like lockers, anti-theft brief case which are costlier and less efficient. The positioning system which is used in this a wi-fi based positioning system instead of GPS, the assembly built of this system is also easier than other systems. The control processor used in this is Arduino.

Yi-Ming et al [7] proposed a system to comfort the delivery in a short distance, this is becoming popular day by day in different countries specifically china. Due to this increasing demand in china it’s essential to come up with a new module for better dispatching of the products. Generally, the pickup time of an order is extended due to the increasing orders as people are becoming more aware to order online and less delivery associates. Due to the constant change in the strategy of order dispatching, this is one of the major reasons which affects the overall logistics industrial service quality. There are two phases in the delivery first is industries and companies send the packages to the logistic service and the second phase is from the courier pick point till the customer’s possession is sequenced by the courier agencies. To overcome this in this paper a new dispatch system is introduced called DODS with a personalized delivery system to improve the efficiency of the delivery in everyday life. Finally, the previous history log is used to improve the efficiency further.

Wei Tu et al [8] proposed the online crowd sourced delivery system for on demand foods to connect from online to offline agencies. In the recent days, online food delivery has become a growing business. Due to the increasing number of online orders, the number of delivery staff required is also increasing and this has become major problem for the food-tec companies and especially the start-ups. This paper focuses on solving such problems by making use of public riders as part time delivery agents. The riders can be compensated with small rewards for their service, hence attracting the crowd to provide their service. Here, they try to make use of technologies like IOT and 3G/4G/5G to connect the crowd with the food joints or food companies. An online solution consisting of all the orders and an efficient delivery route will be generated for the crowd. A hybrid mathematical solution and machine learning is employed to assign food delivery tasks and generate the shortest delivery route in real time. The crowd sourced riders are shared among various food delivering companies according to the area in which they operate. Although this method does not require any kind of major investment on hardware it requires allot of programming. Even if this method is implemented its efficiency is dependent on the crowd. The food being delivered is also not being secured and hence it can be tampered which is bad for the brand of the company.

Tanja Niels et al [9] Designed an effective way in reducing not just the complexity present in the delivery system but also helps the common issue faced in metropolitan cities in our day-to-day life. Due to drastic increase in the logistics industries globally, there is high demand in shipping of packages sent by courier, Express and parcel service which eventually is affecting in way of increase in the traffic density mainly in cities. The delivery tours run by the courier companies are done through diesel truck which in turn causes increase in traffic congestion and lead to air pollution. The come up with an innovative solution this paper proposes a solution for a last mile courier delivery the allocated companies’ cargo bikes and Electronic bikes. The procedure goes by placing the reserved containers and truck trailer in a specific central region of the city which act as a mobile depot (pick up station) for delivering the packages to the nearby location. They analyse the conventional delivery data gathered and present optimization scheme for figuring out suitable location for the designated container, and further have come up with a simulated route for the cargo and E-bikes. This approach is feasible in densely populated and congested cities. The prime aspect of this approach is also to reduce fuel consumption which is reduced by implementation of the specific E-bikes, the vehicle mileage given by truck is drastically reduced from 170 km to 43km approximately. Even in this project there is no safety provided by the
author, but we can also pool our IPS concept here for the safety of few of the expensive cargo in a secured manner and provide even more efficient way in the logistics industries.

Nivedita G et al [10] proposed an Automation of parcel delivery collection using IOT to avoid answering a person at the door or for collecting a door delivery to deal with such problems they came up with a solution to avoid the constraint of the availability of the customer at the time of product delivery using various IOT applications. Their idea is to introduce a Smart Freight Box (SFB). The Smart freight box is a courier collecting Box which is to be installed in our home like A/C at a place where the customer can access it both from inside and outside. It consists of barcode sensor, weight sensor loading cell and doors on each side of the box for putting and collecting the parcel as when the customer is out there. It will also contain a shifting belt where the parcel is placed in the beginning. After verifying the parcel, it will be shifted inside a ward where it is safe until the customer comes and accesses it. There are three phases in SFB, first one is pre-delivery phase where the customer will place an order online to a website, After the confirmation of the order the retailer will send the package details which includes barcode and the weight of the package, the customer can store these details. The next phase is the delivery phase where the delivery worker walks in and places the delivery on the SFB, The SFB validates the parcel with two parameters One is Barcode and other is its weight which is already given to the customer beforehand, the weight sensor loading cells checks the weight and shifts it inside through a shifting belt and the barcode sensor verifies the barcode. In the last phase which is post-delivery phase, the delivery worker has to send an acknowledgement to retailer that the parcel has been successfully placed after confirming with the customer.

G Prabhakaran et al [11] proposed storage monitoring for food grain processing industry using embedded system in a way that is useful for monitoring the food grain storage in the warehouse or the storage unit where due to faulty management leads spoilage and lack of maintenance of these agricultural products, so to overcome this issue they are proposing a simple circuital storage unit that innovates a process in which the ultrasonic signals are echoed through the storage unit and the expected waves is being received by the other end by the required receiver for the constant monitoring of grain condition and quality aspects of them. An additional feature or one more important specification of this project is that, this process helps in anticipating the threats that are faced due the rodents such as bugs and rats which are very common threat that is faced in our day-to-day life, one good reason to implement this process is the drawbacks of old practice who’s setbacks can be infiltrated in this process, some of them are delay in the output signal and signals obtained on the condition of the food is not prioritized. The working principle of this project involves a circuital combination of microcontroller with echo pins for penetrating the sound waves through the grains present in the storage container, in which with the help of microcontroller and the required echo pin mounted on the circuit board, the sound waves (ultrasonic waves) are transmitted on the top of the grain container which is of conical shape however this prototype can be fabricated to any storage unit accordingly. The designated waves are travelled form the triggered echo pin and is reflected back from hitting on the grains to the receiving end of the circuit. Now the received output signals are designated to the microcontroller and the signals are processed by the programmer to convert CMOS logic into desirable input for the microcontroller and then the processed data is displayed in the LCD display accordingly. This method is helping the consumers, wholesalers, mainly farmers in overcoming the major drawbacks pf the traditional method of grain storage this method also provides flexibility to look into the status and condition of grain. Anyways the major setback caused due to rodents which leads to spoilage are overcame in a systematic manner in this technique. This type of system overcomes traditional approach drawbacks of grain storage and gives efficiency and flexibility for accessing grain data and minimizes the grain wastage.

Ajay Doltade et al [12] proposed a basic overview of maintenance in the storage units to monitor the physical aspects of the storage centres that are used for storing agricultural -based products these agricultural -based products. This agriculturally based products are considered as staple food and are primarily consumed by most of the population. IOT and few basic sensors are used to monitor various physical parameters inside the storage unit, with the help of IOT an alert is sent to the concerned personal and hence constantly monitoring the conditions of the storage. Basically, this concept has an approach of monitoring grain storage or any other edible products which might undergo spoilage if not subjected to suitable physical parameters. This paper focuses on improving the condition of such storages with the help of various sensors like DHT11, MQ2, MQ135 and PIR sensors which are based on the concept of IOT. This technique
relies on wireless communication to the Blynk application and desktop system which intern makes this process simple. The desktop system will provide information regarding captured data. The data will be interpreted in terms of graphs and charts. The desktop system monitors the necessary parameters through local area. In the absence of a manager or a concerned personal this application will serve the purpose of maintenance. This Technique is unfortunately limited to only agricultural-based products and it does not detect any kind of intrusion. This concept fails to protect the necessary product from any kind of theft or other such mishaps.

IV. 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.

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