Analysis, Design and Implementation of a Web-Based Online Auction System

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***ABSTRACT*— This paper presents a study on the security challenges faced by online auction systems and proposes strategies to address them. The research methodology involved a literature review of existing studies. The main findings of the study suggest that the most common security threats faced by online auction systems include hacking, phishing, and fraud, which can have serious consequences for both buyers and sellers. To address these threats, the paper proposes a number of strategies, including the use of encryption, two-factor authentication, and secure payment systems. The study concludes that improved security measures in online auction systems can help to increase trust and confidence among users, which in turn can lead to greater participation and revenue for the industry. The implications of the study for the online auction industry and potential directions for future research are also discussed.**

Keywords: - Online Auction, Seller, Buyer, fraud, phishing

I. INTRODUCTION

A key element of the electronic market are auction systems, which enable consumers to purchase and sell goods from any location. Anything that they have may be put up for auction by the sellers, and whoever places the highest bid is the winner [1]. Online auction is a different type of business, here price bidding is done for any item to be sold. Every Bidding has one starting price and limited time.

An item's price is determined through participant competition in an auction, a type of market. Typically, the sellers can sell one item at a particular time, and while the auction is still going on, buyers can place their bids at any moment. The popularity of auction has increased recently thanks to online auction. There no particular time and location to attend an online auction as compared to offline auctions. Online marketplace sites like eBay.com, Amazon.com, and Yahoo.com are among the most popular ones [13].

Online auctions may be divided into three categories based on when they take place: pre-auction, in-auction, and post-auction [2]. Additionally, the outcomes of auctions may change dependent on achieving specific corporate goals including boosting sales, guaranteeing the best price, and ensuring little collusion [3]. It includes a wide range of things, including trip packages, consumer electronics, books, clothes, and even electronic content itself [5]. Handheld computing devices like palm computers are getting more affordable and well-liked at the same time as mobile computing technology is developing. This opens up possibilities for creating more sophisticated auction services. For instance, a user may use his portable device to send a bidding agent to the network from any location and manage the agent operations [7].

This online Auction System will act as a platform that will bring various buyers and sellers together i.e., buyers who want to buy an item and sellers who want to sell the item. As a seller, one needs to upload their item for auction with a minimum bid and as a buyer, one can place a bid for the item.

Online bidding is an extended market and hence not restricted to the general population of a specific zone. For e.g. If you are searching for a service provider for your site, you require not to sit tight for a more extended time. You should simply post a promotion on the web and welcome the viewers to offer. You can likewise settle a bidding time and once the course of events is shut, you can check for the bidder who falls under your criteria. You can additionally talk about the necessities and close the Online bidding at the most punctual. The whole work talked about so far does not cost anything. In this way, a course of events can be settled to finish the venture and close the work at the most punctual.

A forward auction is a type of auction process where a seller offers goods or services for sale to the highest bidder. In a forward auction, the bidding process starts at a low price, and bidders increase their bids in increments until only one bidder remains. The highest bidder wins the auction and is obligated to purchase the goods or services at the winning bid price. This paper presents a study on the security challenges faced by forward online auction systems and proposes strategies to address them.

Rest of the paper has structured as follows. Section II review the existing literature. Section III explains the working of system analysis Use case, and proposed algorithms. Section IV consists of system implementation algorithms, and result. Section V consists conclusion and future work.

II. LITERATURE REVIEW

Ebay.com is the most famous auction website till date and we have considered it as the existing system in this research paper. eBay is considered as the largest online

market in the world which enables both local and international. Users on eBay can buy and sell products using online auction forms, often known as auction-style posts, or by direct purchases through "purchase it now" buttons. Pierre Omidyar designed eBay in 1995. eBay allows users to register, connect to the website, and have a home page with a broad explanation of the portal. It also provides a personal page where users may check the status of their auctions or offers. Bidding of Products can only be done in this existing System.

Huuto.net is a Finnish online auction platform comparable to the worldwide eBay. In 1999, Lari Lohikoski designed it in Helsinki. The term "huuto" comes from the Finnish word "huutokauppa," which translates as "auction". Same as eBay, huuto also has the mechanism to login, register as seller and buyer [10].

The paper by Jing et al. (2008) describes an architectural design of an online auction system with AOSAD. The system includes four modules: User Management, Auction Management, Order Management, and Payment Management. The User Management module handles user registration and authentication, while the Auction Management module allows sellers to create auctions, and buyers to participate in auctions. The Order Management module tracks the status of orders, and the Payment Management module handles payment transactions. In comparison, our research paper focuses on developing a secure online auction system using public key cryptography, digital signatures, hash functions, and SSL. Our system ensures secure communication, data confidentiality, and integrity, as well as authentication and non-repudiation. We also discuss the limitations of previous research and propose future work. In contrast, the paper by Jing et al. (2008) does not address the security concerns of an online auction system. However, both papers aim to improve the functionality and efficiency of online auction systems, albeit through different approaches [6].

The paper "Distributed Agent-Based Online Auction System" by Badica et al. (2014) presents a distributed agent-based architecture for an online auction system. The proposed system consists of multiple agents, each responsible for a specific task, such as handling bids, managing auctions, and enforcing security policies. The system uses a combination of cryptographic techniques, such as digital signatures and secure sockets layer (SSL), to ensure the security of transactions and prevent fraud [4]. The authors also describe the implementation of the proposed system using the JADE agent platform and evaluate its performance and scalability through simulations. The results show that the proposed system is capable of handling a large number of concurrent users and auctions while maintaining good performance [4].

The paper "Online Auction System" by Aljaf (2016) provides an overview of the design and implementation of an online auction system. The author highlights the key features of the system, including the ability for buyers and sellers to register and create accounts, the use of email notifications to alert users of auction updates, and the implementation of a bidding system that allows buyers to place bids and sellers to accept or reject bids. The paper also discusses the challenges faced during the development process, such as ensuring the security and privacy of user information [10]. In comparison to our research paper on secure online auction systems, Aljaf's paper provides a basic overview of online auction systems without delving into the specific security measures that should be implemented. Our research paper focuses on the implementation of public key cryptography, digital signatures, hash functions, and secure socket layer in order to ensure the security and privacy of the online auction system. Additionally, our paper addresses the limitations of previous research and proposes future directions for research in this area [10].

The paper by Omar et al. (2021) proposes a decentralized auction system using blockchain smart contracts. The authors argue that the decentralized approach eliminates the need for intermediaries and offers a more secure and transparent system. The system uses Ethereum blockchain and smart contracts to manage the auction process, with participants having their own digital wallets to store and transfer funds. The authors also highlight the benefits of smart contracts, which automatically execute the terms of the auction, ensuring that the process is fair and transparent. In comparison to our research paper on secure online auction systems, there are similarities and differences between the two approaches. Both papers aim to address the challenges of traditional online auction systems and propose alternative solutions. However, while our paper focuses on implementing security measures, such as public key cryptography and digital signatures, to ensure the authenticity and integrity of the auction process, Omar et al. (2021) propose a decentralized approach that relies on blockchain technology and smart contracts. Another difference is that while our paper focuses on a centralized auction system, Omar et al. (2021) argue that a decentralized approach offers more benefits in terms of transparency, security, and efficiency [3].

III. SYSTEM ANALYSIS

Based on the aforementioned research, a thorough empirical investigation is offered. The system was created with consideration for the needs of the industrial partner. In this part, the system design is discussed.

In System Analysis, we are going to cover the analysis of modules using different diagrams like Block Diagram, Data Flow Diagram, Methodology and Use Case Diagram.

There are basically two main modules involved in an online auction System i.e., a Seller Module and a Buyer Module. Seller's work to sell or put items in auction and Buyer's work is to make a bid on item.

A. Modules

1) Buyer Module:

Buyer Module will be having a registration process, a login process, a profile verification step and a dashboard which shows Auction Products i.e., product gallery where they can bid for product and purchase product.

2) Seller Module:

It includes the retailers who want to sell their products. It includes adding a new product, deleting an existing product, modifying information like prices or basic information.

B. Block Diagram

A block diagram is a depiction of a system's major components or operations using blocks connected by lines that highlight the links between the modules.

In the Figure (1), diagram predicts the basic online auction process held during Auction. Sellers and Buyers account transferred to the system from the database, then the system checks if the logged in user is legit imitate or not, then after validation, both seller and buyer go into the auction mechanism or process.

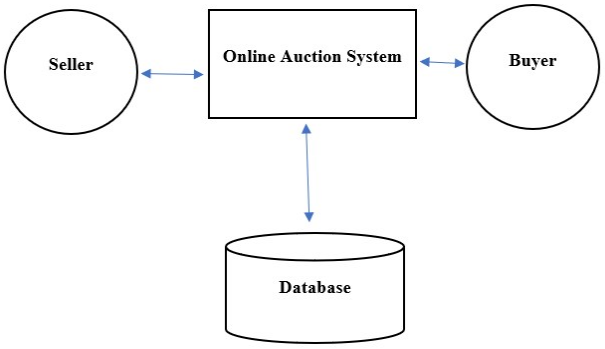

Fig. 1. Block Diagram

C. Data Flow Diagram

A data-flow diagram is a graphic representation of how data flows through a system or process. The DFD also provides information about each entity's inputs and outputs, as well as the process itself. The major goal is to demonstrate the interaction between the actor and the use cases. Its purpose is to portray the system requirements from the viewpoint of the user. The tasks carried out by the module are the use cases [8].

User Management work is to validate the user using their username and password while Auction Management work is to manage the auction i.e., items price, its details and Bid Management is to manage the bid i.e., the users that are bidding, the current bid price and all that.

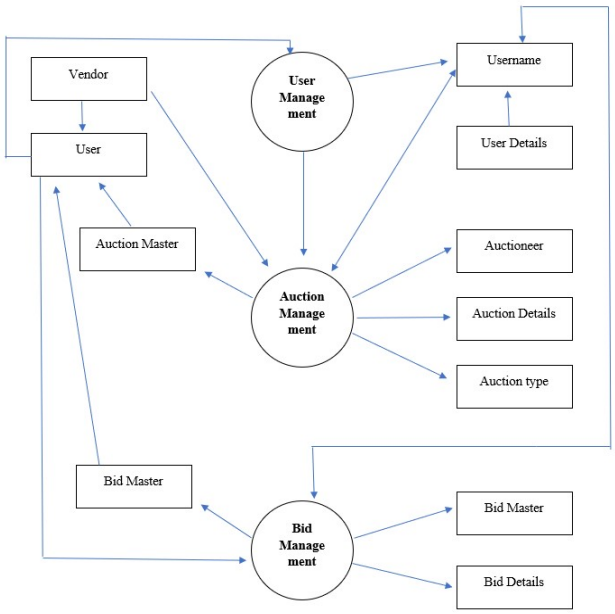

Fig. 2. Data Flow Diagram

In Figure (2), Data Flow Diagram shows all the Functions of user Management, Auction Management and Bid Management Systems. It can clearly depict the relationship between their functions.

D. Use Case Diagram

Activities that the Users (Seller and Purchaser) in an auction's Use Case Diagram is shown in Figure 4. Users may choose after logging in, the technique of bidding and the kind of auction (auction, reverse auction). They can also share information about things or offer views about them. Purchaser's behavior Use Case Diagram is shown in Figure 5. It outlines the buyer's actions when they enter an auction after logging in.

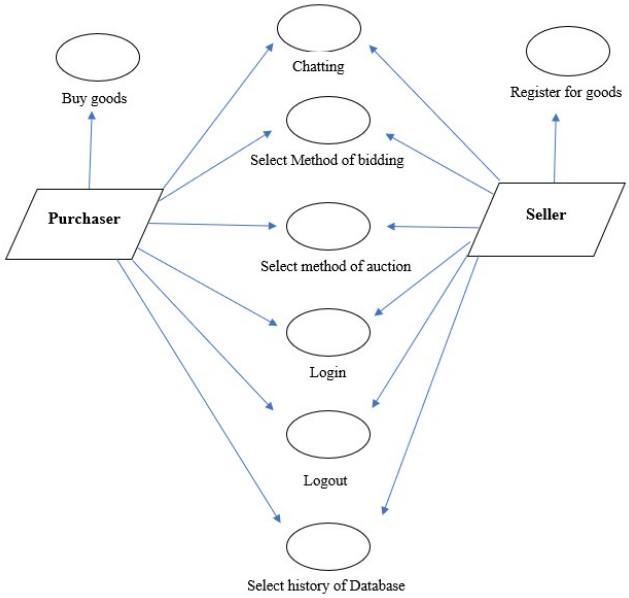

Fig. 3. Auction System's Use Case Diagram

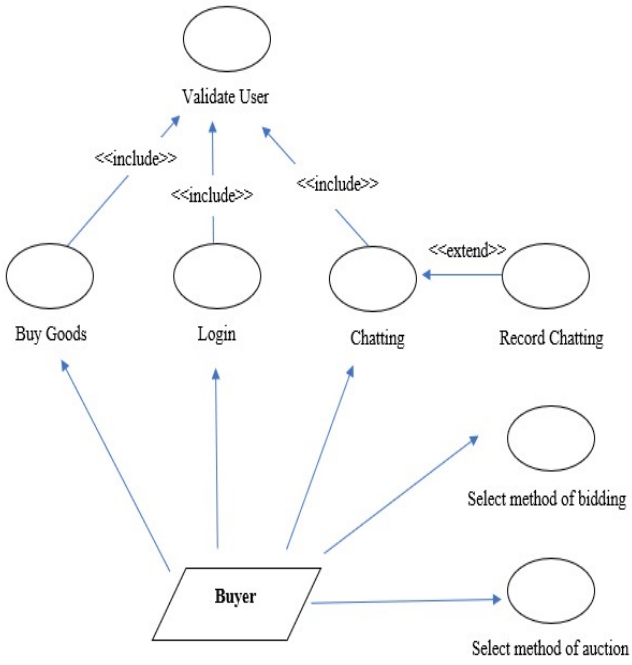

Fig. 4. Buyer's Use Case Diagram

IV. System Implementation and Result

Now, in this part, we are going to discuss the algorithms that are being used to implement the Online Auction System which in turn will help us to understand the working architecture of Online Auction System.

A. *Algorithm 1 (Seller Submits Auction Specifics)*

Algorithm 1 will help us to understand the pre-auction process that seller has to go through in need to start the Auction.

If logged in account is in the database and is a Seller account, then, seller can add product for auction and can notify seller so that they can participate in the auction. Seller has to provide the starting price i.e., pre-auction price.

Else logged in account is not in the database or not a seller account, then it will not accept transaction from that account.

Inputs: Product Description, Pre-Auction, Price Bid Decrement, Auction Duration
1. if LA = Seller's LA then
2. Permit the addition of the inputs as a legitimate transaction.
3. Inform Buyers that they are welcome to take part in the auction.
4. Starting price is equivalent to the pre-auction price.
5. end
6. else
7. Never accept transactions from unlicensed LA.
8. end

B. *Algorithm 2 (Seller's Assessment Process)*

Algorithm 2 shows the steps where buyers can participate and submit their respective bids for the item.

If buyer participated and logged in account is equal to the seller's account then allow the bids to get added and count buyers and also notify buyers that auction is still open.

Else logged in account not in the database or is not seller's account or no buyer is participated, then, do not accept the transaction.

Input: List of the Buyers
1. if buyers participated and LA = Seller's LA then
2. Ensure that the address is address as a legitimate transaction.
3. Count how many buyers there are.
4. Remind buyers that the auction is still open.
5. end
6. else
7. Never accept transactions from unlicensed LA.
8. end

C. *Algorithm 3 (During the auction, buyers placed bids)*

Algorithm 3 depicts the steps needed to bid during auction time interval by the buyer.

If logged in account is in the database and is the buyer's account and auction is still open, then we will add bid to the list of all bids with its respective buyer address.

Else logged in account not in the database or is not buyer's account then, do not accept the transaction.

If New Bid is greater than or equal to (Leading Bid – Bid Decrement) then Leading Bid will equal new bid of respective buyer, else, leading bid remains the same.

Input: List of bids of Buyers
1. if LA = Buyer's LA and current time < deadline then
2. Approve the addition of the bids as a legitimate transaction.
3. Bids are mapped to the appropriate Buyer Address.
4. end
5. else
6. Never Accept transactions from unlicensed LA.
7. end
8. if New Bid >= (Leading Bid – Bid Decrement) then
9. Leading Bid equals new Bid of Respective Buyer.
10. end
11. else
12. Leading Bid Doesn't change.
13. end

D. *Algorithm 4 (Announcing the winning bidder)*

Algorithm 4 depicts the steps needed to announce the winner of the auction.

If the time meets the deadline and logged in account is in the database and is the seller's account then notify sellers that auction is closed, person with highest bid will be announced as winner and the winning bid value will be transferred to the seller.

Else logged in account not in the database or is not equal to seller's account then, do not accept the transaction.

Input: List of all submitted biddings
1. if current time > deadline and LA = Seller's then
2. Remind buyers that the Auction is closed.
3. Announce the winning bid as an event.
4. Transfer the winning bid value to its respective Seller.
5. end
6. else
7. Never accept transactions from unlicensed LA.
8. end

E. *Algorithms that can be used to make secure*

There are several algorithms that can be used to make online auction systems more secure. Some of the most common algorithms include:

- Public Key Cryptography (PKC): PKC is a type of encryption that uses two keys, a public key and a private key, to secure communication. In online auction systems, PKC can be used to encrypt the communication between the user and the system, ensuring that the information being transmitted is confidential and cannot be intercepted by unauthorized parties.
- Digital Signatures: Digital signatures are used to verify the authenticity of a message or data. In online auction systems, digital signatures can be used to ensure that the bids placed by users are authentic and have not been tampered with.
- Hash Functions: Hash functions are used to create a unique digital fingerprint of a message or data. In online auction systems, hash functions can be used to ensure the integrity of the bids placed by users.
- Two-Factor Authentication (2FA): 2FA is a method of authentication that requires users to provide two forms of identification, such as a password and a security code sent to their phone, to access the

system. In online auction systems, 2FA can be used to increase the security of user accounts and prevent unauthorized access.

- Secure Sockets Layer (SSL) or Transport Layer Security (TLS): SSL or TLS is a protocol for establishing secure links between networked computers. In online auction systems, SSL or TLS can be used to encrypt the communication between the user and the system, ensuring that the information being transmitted is confidential and cannot be intercepted by unauthorized parties.
- Access Control: Access control algorithms are used to restrict access to a system based on user credentials. In online auction systems, access control algorithms can be used to restrict access to sensitive information, such as user bids, to only authorized users.

F. Results

We have run all these algorithms on our system. These algorithms result in providing the comfort running of a system.

Algorithm 1 and Algorithm 2 runs from the seller side while Algorithm 3 runs from the bidder side and Algorithm 4 helps in predicting the winner of the auction. These 4 algorithms combine to form our Online Auction System.

The EA enables network participants (Sellers or Buyers) to communicate with each other by invoking specific functions. Initially, the buyer installs the contract and calls the Pre_auction_stage() method to upload auction parameters such as pre-auction price, duration, and bid decrement. This event triggers the Auction_open() event, alerting all potential buyers. At the start of the auction, a timer is set, and the time information is gathered from reliable oracles, which triggers the buyer_participation_open() event, indicating that the auction is now open for participation. Buyers participate by entering the bid price into the buyer_participation() function. Only new bids exceeding the existing leading bid and the bid decrement are accepted as successful transactions during the bidding process, as outlined in Algorithm 4.

Finally, after the time limit has passed, the contract calls on trusted oracles to reject any bids received beyond that point. The auction ends, and the winning bid is broadcast to all buyers through the Auction_ended() event, and the winner transfers the winning bid amount to the relevant seller. Bid Processing Times are shown in Table (2). Many Scenarios are tested to determine the bid processing times.

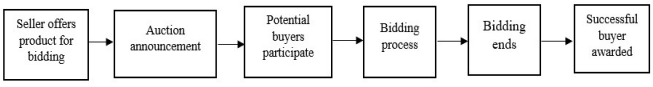

Fig. 5. Forward Auction Process

TABLE I. FUNCTIONS AND STAGES

Stage	Function	Permissions
1. Sellers Specification	pre_auction_stage	Seller
2. Buyers' participation	buyer_participation	Buyers
3. Buyers' Bid	buyers_bidding	Qualified Buyers'
4. Auction closed	confirm_winning_bid	Seller

TABLE II. BID PROCESSING TIME (IN MILLISECONDS)

Total Number of Bids	Auction Size					
	8	12	16	20	24	30
1,000	10	40	40	40	40	40
5,000	20	110	170	180	180	190
10,000	20	160	350	370	370	380
15,000	30	170	520	540	540	560
20,000	40	170	630	690	700	740
25,000	40	180	800	850	910	920
30,000	40	190	890	1130	1130	1140

V. CONCLUSION AND FUTURE WORK

The secure online auction system presented in this research paper has demonstrated a robust and reliable approach for conducting online auctions in a secure manner. The proposed system addresses several critical security issues that are commonly encountered in online auction systems, such as confidentiality, integrity, authenticity, and availability. Through the use of various cryptographic techniques, such as public key cryptography, digital signatures, and hash functions, the proposed system provides a secure environment for conducting online auctions. Additionally, the use of SSL/TLS protocols ensures that all communication between buyers, sellers, and the auction server is secure and protected from malicious attacks. Overall, the proposed system can be a valuable addition to the current online auction market, offering buyers and sellers a secure and transparent platform for conducting transactions. However, there is still room for improvement, and future research can explore additional methods for enhancing the security and efficiency of online auctions. Additionally, research can also focus on implementing the proposed system in real-world scenarios to evaluate its performance and scalability.

One potential avenue for further research could be exploring the integration of machine learning algorithms to detect and prevent fraudulent behavior during online auctions. This could involve analyzing bidder behavior patterns, bid amounts, and auction history to identify potential instances of fraud or collusion. Another potential area for improvement could be enhancing the user interface and user experience of online auction systems to make them more user-friendly and accessible to a wider range of participants. This could include improving bidding interfaces, integrating real-time chat functionality, and simplifying the registration and bidding process. Finally, future research could also focus on exploring the potential of emerging technologies such as blockchain and decentralized systems to create more secure and transparent online auction systems. This could involve designing and implementing auction protocols using smart contracts and exploring the use of blockchain-based identity verification and authentication mechanisms to enhance the security and trustworthiness of online auctions.

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