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Design and Analysis of high security ECC based Cryptography by Holomorphic and data storage in Cloud

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ABSTRACT

Recently, Due to various hacking approaches, the protection for any data transmitted through any channel or mode is one of an important issue. Nowadays, providing security level to data is satisfactory, the development is extended for obtaining data among the sender and receiver. The level of security depends on the size of a synchronous key which is employed for encryption and decryption using various cryptography systems management and in modern approaches like AES, reed Solomon codes and block codes use larger key size simultaneously and there exists security problems because of hacking techniques. To describe the security level and hacking problems, the new ECC is presented and employing scalar duplication synchronous key is generated which includes point doubling and point addition. The created focuses are encrypted before transmission by using ECC-Elgamal-Holomorphic (ECCEH) and transferred through a remote channel and the encoded data is failed at collector using ECCEH with reverse operation. The complete novel cryptography context has been generated by MATLAB; the defined framework has endeavored as far as speed, delay and control and many others accepted in Matlab 2017a. The user of the sender, the original information is transformed into integer value by employing Holomorphic and encodes it by utilizing the Elgamal ECC algorithm which employs point doubling and point addition. The encoded information is uploaded into the cloud for storage, here www.thingspeak.com is utilized for storage.
When the user at the receiver request to the cloud to access from the cloud, firstly cloud server verifies the access control policies of the requester, and then the cloud server provides access. If the user verified, the policies, then encrypted data can download and use the synchronous key to decrypt the original data using the ECC- Elgamal algorithm. Between decrypted and original data, the different performance parameters are evaluated in terms of execution time, packet delivery ratio, throughput, latency and compared these results with traditional techniques and it found that there is 12%, 31%, 24%, and 8% improvement in execution time, packet delivery ratio, throughput and latency.

Key words: Cryptography, ECC, Point addition, point doubling, Security system and ECCEH.

1. INTRODUCTION

Since the development is rapid, attempts are made to prevent hacking of data by the study of researchers and industries. To exchange the information via communication media securely, the best technique is ECC cryptography which is more secure than all other cryptography techniques [26, 27]. The ECC generates varied keys sizes and also for a given information encoding and decoding is performed.

The IoT concepts can be solve problems which are based context modeling developed by using dynamic and genetic methods. The genetic methods for best matches among group of contexts and reference contexts and also measure the excellent degree for every context available in the model [34]. In the educational system, the major channeling are verifications of certificates, these problems can resolve for verifications using cloud based framework which are based on QR codes and RFID [35]. In medical shops and other health caring shops, there is issue for caring about expire date and old items keeping creates a health issues for human beings, to overcomes these problems, in [36] proposed health care managements approach by authorities which uses novel sampling methods. The major issues in communications are security and data transmission at higher rates, in [37] proposed multilevel security algorithms are discussed for data encryption and decryption. ECC employs both private and public-key cryptography. Simultaneously, the Conventional key cryptography structure provides more security, accordingly, one such cryptography strategy is ECC. The basic advantage of ECC over RSA is that based on the applications and requirements ECC supports smaller key to larger key sizes and as a result managing multifaceted quality will be reduced [1]. The point addition, point multiplying and scalar additions are basic operations of ECC to determine focuses on the curve. This point operation facilitates encryption and decryption operations. The Elgamal approach is a part of ECC operation which is one among such point operation similarly enhances for statically synchronized and it operates in the same way as one to N mapping techniques explained in [2]. In mapping approach, the x-y co-ordinators are mapped with the alphanumeric characters, numbers

gradually and is extremely difficult for an intruder to identify the mapped character or number, hereafter the mapped technique is used in this context and is referred as grid mapping technique and it assures security for the information and also keeps away from the encrypted information.

Exchanging the data between the sender/transmitter and recipient/client is the major drawback of the crypto technique which is confined using the ECC Diffie-hellmen-Merkle key exchange by carrying out a scalar addition to generate the focal points such as P, 2P,3P,4P, … .563P. The generated point P=f(x,y), obtains 563 focuses, the point addition, and point multiplication are used and these techniques reduce complex arithmetic operation like addition and divisions; consequently, the casualness of framework is reduced and speed enhances [30].

Elgamal strategy and reed Solomon codes are employed by the sender message to speed up the process with a transmission speed of 200Mbits/sec [3]. The transmitted message is stored in (M+M_s*(M_R*G)), where the message is represented by M, sender message denoted as M_s, receiver message by M_R and G is generator point and (M_s*G, M+M_S*(M_R*G)) encrypts the message and error variations in memory is presented in [4]. The sender key KR and registers K_R*(M_s*G), with the help of specific key M the information is decoded by the receiver by employing M+M_s*(M_R*G)- K_R*(M_s*G) in [5] and it is more consistent and reduces the additional bits in memory devices. To implement NoC and SoC excess operations performed are reduced and these frameworks are straightforward and part of the codes are exhibited in [6]. Several bits of error modification, accurate fault resistance devices such as Content Addressable Memories (CAMs) and accurate error correction for memories like SRAM and other memories devices have been suggested in [7]. Information exchanging devices such as NoC and SoC structures requires error modification techniques to decrypt the information at receiver and information exchange is effectively shown in [8]. In terms of points representation for the characters ElGamal is better than Menezes ECC systems and ElGamal, schemes consume less power and it operates at high speed in FPGA and ASIC design and the fields represented over the curve are $F_p.F_p$ [22]. Later, the concept of ECC has been developed by the researchers, elliptical curves play a significant role in cryptography which employs number theory and security level systems [17]. The ECC technique has been utilized in the factorization of integer numbers and it is very useful in solving the Fermat's theorem suggested in [18].

In 1985 Koblitz and Miller invented ECC [12,29] and it is employed to generate a secrete key which provides high security and is practically available, the curve w.r.t point P on the curve is denoted by $p(x_{[i]}, y_{[j]})$ for all values of P and it must satisfy the equation given below at infinity point [15].

$$y^2_{[j]}+c_1x_{[i]}\, y_{[j]}+c_3y_{[j]}=x^3_{[i]}+c_2x^2_{[i]}+c_4x_{[i]}+c_6$$

The curve w.r.t point P for elliptical curve K is P(K), the points on P for all values P for many fields are outlined in [14]. The ECC field is generally expressed in form of complex numbers which comprises both real and rational numbers associated with finite curve field, to provide high security both fields employs prime number and the complications in ECC systems depends on decoding ability of the curve which is typically referred as Discrete Logarithmic Problem (DLP) [16,33]. ElGamal cryptography is one of the well-known algorithms in ECC which provides high security for both encryption and decryption is conferred in [13, 16]. Diffie and Hellman presented cryptography [20] in the year 1976 to exchange the key as a public key, in the later stage, RSA has been designed for less key size [19]. IEEE 802.16 protocol is mostly used for WiMAX protocol to transmit the information wirelessly which is part of the physical and control layer in the OSI model to utilize in point to point communication and it employs mesh type topology. Excluding these two layers, there are other types of the layer which provides security to the data and authorizes, authentication of data is conferred in [23, 28]. To encode the data, instead of using the control layer physical layer is used for modulation of the carrier signal and modulation of frequencies. MAC is the fundamental submodule for security and it will function as convergence and monitoring the data transfer from sender to receiver [24,25]. In the ECC concept, the novel approaches presented for data encryption are Menezes Vanstone which fundamentally divides the main module into smaller blocks similar to the pipeline process and it comprises one character in terms of the hexadecimal format. Each hexadecimal value has two digits to represent the information as point [21].

2. METHODOLOGY OF PROPOSED RESEARCH WORK

Many approaches from various study areas and also researchers, endeavors have been failed to provide security to messages, computerized data, special characters, and pictures [9]. Key size is the fundamental parameter for all these applications if the key size is large, the security level is high [10]. There are many encryption and decryption computations, for example, BCH, hamming codes, piece codes such as LDPC, RS codes and AES, out of which AES employs excessive key size i.e. 256 bits and other computations utilizes the key size of just 8 bits. A most important challenging framework has been developed at that point which provides high security and key size termed as Elliptic Curve Cryptography (ECC) since this framework achieves high security with the help of resources [11]. In the existing work, a new concept is proposed to develop a typical framework that provides high security for various types of information. In this design, ECC has been fine-tuned for 256 unique keys size to form a 16x16 framework; each key size is 32 bits which includes two distinctive characters know by the sender and receiver. This unique character combines x and y plans given in equation (1).

$$\text{Key}_{\text{special characters}} = (x \,\&^{*}\, y) \quad (1)$$

Where & is the special character of sender and * is the special character of the receiver

The designed highly protected and the less complex system comprises, the cloud architecture, system handling for complexity and management of cloud access control. This

system is performed for multiple users with various cloud models with high security and recovery of the data [31-32]. As depicted in Fig.1. it has several phases of process which is described below:

- Creation of account in a cloud by using personal information along with the secrete key.
- Obtaining biomedical signals and images such as EEG/ECG and Endoscope Ultrasound Image.
- By employing the Holomorphic algorithm, the signals and images are converted into integer format.
- Encryption through ECC- ElGamal algorithm.
- The data is stored in the cloud via different channel IDs and passwords.
- Access policy authentication in a cloud server.
- Decryption by ECC- ElGamal algorithm

In the ECC cryptography context, the new algorithm facilitates a restricted form of elliptic curve that is considered over a limited field (ffp). The essential number is p referred to as "mod p", it is an elliptic grouping and p consistently s prime number and it is illustrated in equation (2).

$$(4G_1^3 + 27G_2^2) mod\ p \neq 0 \qquad (2)$$

The elliptic group is represented by E_p and mod p of coordinates (x,y) is the pair of nonnegative integer and less than p, it should satisfy the equation (4.3)

$$y^3 = (x^3 + G_1 x + G_2) mod\ p \qquad (3)$$

The $E_p(G_1, G_2)$ group has numerous points as well as all special characters and infinity (Ω).

Generation of points on the curve

Generation of points on the curve

To satisfy the eq (2) and eq (3), G1=1 and G2=1 is chosen. To set up 16x16 network, the total number of focal points required is 256, for which p=463 is selected, according to ECC control, higher the p values gradually increase the security of the defined framework [12, 21]. The p number value goes from 1 to 463 and replaces all numbers in eq's (4 and 5) on LHS and RHS sides. The condition of LHS is addressed in eq (4) and RHS condition is specified in eq (5).

$$y_{coordinate} = y^2 mod\ p \qquad (4)$$

$$x_{coordinate} = (x^3 + G_1 x + G_2) mod\ p \qquad (5)$$

The computed values of LHS and RHS are listed in Annexure-4.1. From the Annexure-4.1, the coordinated directions point (x, y) are known, for p=463 there are just 10 coordinated focuses and those coordinated are recognized. One of the coordinated focal points is preferred as the initial point, i.e. P= (125,273) and make use of this basic point, the following focuses such as 2p,3p,4p,5p, … ..,256p are calculated by using point addition (PA) and point doubling (PD). The figured 256 focuses are noted in Table.1. The advantages of PA and PD are to reduce the number of arithmetic operations and scalar addition i.e kp where k is constant and changes from 1 to 463. The conditions of PA and PD are mentioned in eq (6) and eq (7).

2.1 Point addition

Let p=(x_1, y_1) and q=(x2, y_2), both p & q are belongs to ff_p then p+q=(x3, y_3)

Where

$$x_3 = \left[-x_1 - x_2 + \left(\frac{y_2 - y_1}{x_2 - x_1}\right)^2\right] mod\ p \qquad (6)$$

$$y_3 = \left[-y_1 + \left(\frac{y_2 - y_1}{x_2 - x_1}\right)(x_1 - x_3)\right] mod\ p \qquad (7)$$

Where $\left(\frac{y_2 - y_1}{x_2 - x_1}\right)$ is represented as λ and if λ is negative then the following special cases are taken into account to satisfy the ECC basic condition,

(1)If the numerator is negative then the either of the following processes can be employed

(i) For the negative numerator, value perform modulo operation (or)

(ii) Take the inverse of denominator then employ signed multiplication

(2)If the denominator is negative then the either of the following processes can be employed

(i) For the denominator, value perform modulo operation (or)

(ii) Take the inverse of denominator then carry out signed multiplication

(3)If both are negative then the either of the following processes can be applied

(i) For the numerator and denominator, values perform modulo operation (or)

(ii) Find the inverse of the denominator and afterward multiply it with numerator

2.2 Point doubling (PD)

If input is single point then PD can be employed to generate a point doubling, for example 2p=p+p, 4p= 2p+2p, 8p=4p+4p, etc. To implement PD on single point say p,2p,4p…, so on, let us consider p=(x_1,y_1) then 2p=(x_3,y_3), where

$$x_3 = \left[-2x_1 + \frac{3x_1^2 - G1}{2y_1^2}\right] mod\ p \quad \text{and}$$

$$y_3 = \left[-y_1 + \frac{3x_1^2 - G1}{2y_1^2}\right] mod\ p$$

By using Point Addition and Point Doubling, the 256 focal points are generated and the same focuses are noted in Table.1. Additionally, this Table is the 16x16 framework. Each point enables both x and y. To achieve smooth operation by advanced processors, the x and y coordinates are combined into a single by inserting two special characters between them. The sizes of each coordinate are 8-bit and the size of a special character is 8 bits, along these lines the total size of the point is 32 bits as given in equation (8).

$$Key_{special\ characters} = (x\ \&^*\ y) = (70\&^*86) \qquad (8)$$

The binary representation of 70 is 1000110, the binary representation of 86 is 1010110, the binary representation of and is 00100110 and the binary representation of * is 00101010, therefore, the equation (8) can be written as

$Key_{special}$ characters=10001101010110001001100010101010.

The 32 bits of binary information are input to the encryption. After successful computations of 256 focal points using PA and PD, every focal point is stored in Look-Up-Table (LUT) and depends upon the 8-bit input information, 32 bits of LUT esteem will be selected. The 32-bit LUT esteem is transmitted through communications subsystems such as Routers or Network Interface (NI). To reduce the power dissipations in

NI before transmitting the information via a communication channel, then data encryption is performed; the obtained encoded information provides less security.

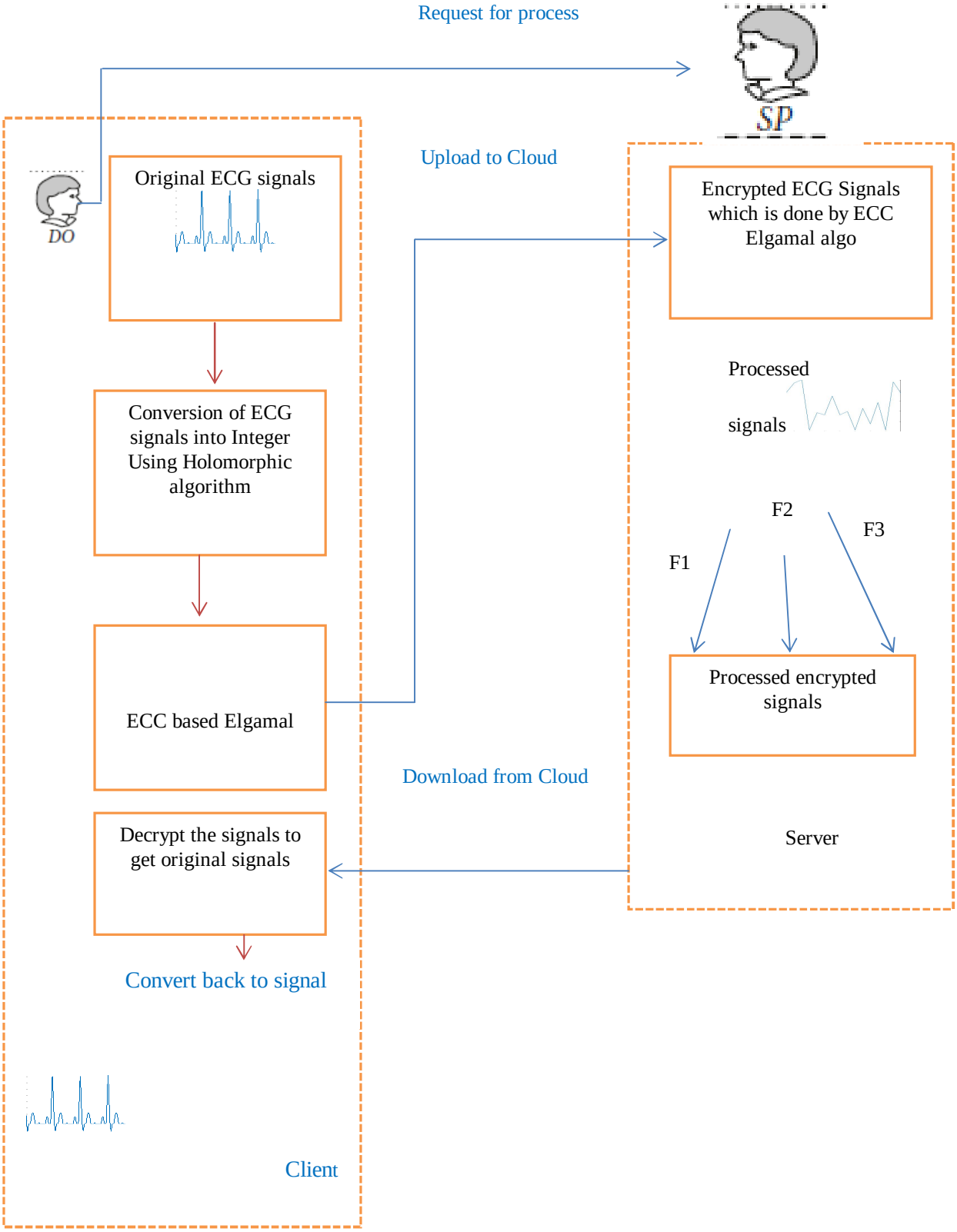

Figure 1: Overall proposed block diagram of secured and storage for biomedical signal biomedical images.

Table.1: Generated 256 points using PA and PD which are on the ECC curve

Points	Points on the elliptic curve							
1-8	(125,273)	(424,69)	(45,154)	(205,71)	(392,297)	(151,42)	(431,380)	(251,37)
9-16	(12,434)	(459,166)	(14,195)	(105,154)	(214,54)	(185,244)	(461,445)	(365,1)
17-24	(71,314)	(457,202)	(404,318)	(67,50)	(265,450)	(75,154)	(297,114)	(122,163)
25-32	(120,219)	(205,252)	(393,52)	(43,36)	(353,186)	(395,159)	(384,73)	(225,328)
33-40	(383,187)	(58,322)	(217,202)	(28,402)	(344,276)	(200,208)	(112,117)	(370,28)
41-48	(432,34)	(42,332)	(424,79)	(303,194)	(50,357)	(350,442)	(201,314)	(172,122)
49-56	(427,185)	(326,37)	(44,164)	(40,453)	(83,210)	(373,281)	(137,100)	(232,305)
57-64	(311,394)	(14,195)	(105,154)	(214,54)	(185,244)	(461,445)	(365,1)	(71,314)
65-72	(457,202)	(404,318)	(67,50)	(265,450)	(75,154)	(297,114)	(122,163)	(120,219)
73-80	(205,252)	(393,52)	(43,36)	(353,186)	(395,159)	(384,73)	(225,328)	(383,187)
81-88	(58,322)	(217,202)	(28,402)	(344,276)	(200,208)	(112,117)	(370,28)	(432,34)
89-96	(42,332)	(424,79)	(303,194)	(50,357)	(350,442)	(201,314)	(172,122)	(427,185)
97-104	(326,37)	(376,220)	(454,455)	(262,459)	(148,419)	(64,235)	(250,59)	(306,248)
105-112	(353,288)	(164,291)	(429,299)	(318,207)	(382,14)	(20,104)	(11,56)	(424,226)
113-120	(154,49)	(231,434)	(36,50)	(65,23)	(46,442)	(356,186)	(163,60)	(217,462)
121-128	(264,453)	(0,172)	(326,35)	(376,220)	(454,455)	(262,459)	(148,419)	(64,235)
129-136	(250,59)	(306,248)	(353,288)	(164,291)	(429,299)	(318,207)	(382,14)	(20,104)
137-144	(11,56)	(424,226)	(154,49)	(231,434)	(36,50)	(65,23)	(46,442)	(356,186)
145-152	(163,60)	(217,462)	(264,453)	(0,172)	(326,35)	(376,220)	(454,455)	(262,459)
153-160	(148,419)	(64,235)	(250,59)	(306,248)	(353,288)	(164,291)	(429,299)	(318,207)
161-168	(382,14)	(20,104)	(11,56)	(424,226)	(154,49)	(231,434)	(36,50)	(65,23)
169-176	(46,442)	(356,186)	(163,60)	(217,462)	(264,453)	(0,172)	(326,35)	(376,220)
177-184	(454,455)	(262,459)	(148,419)	(64,235)	(250,59)	(306,248)	(353,288)	(164,291)
185-192	(429,299)	(318,207)	(382,14)	(20,104)	(11,56)	(424,226)	(154,49)	(231,434)
193-200	(36,50)	(65,23)	(46,442)	(356,186)	(163,60)	(217,462)	(264,453)	(0,172)
201-208	(326,35)	(376,220)	(454,455)	(262,459)	(148,419)	(64,235)	(250,59)	(306,248)
209-216	(353,288)	(164,291)	(429,299)	(318,207)	(382,14)	(20,104)	(11,56)	(424,226)
217-224	(154,49)	(231,434)	(36,50)	(65,23)	(46,442)	(356,186)	(163,60)	(217,462)
225-232	(264,453)	(0,172)	(326,35)	(376,220)	(454,455)	(262,459)	(148,419)	(64,235)
233-240	(250,59)	(306,248)	(353,288)	(164,291)	(429,299)	(318,207)	(382,14)	(20,104)
241-248	(11,56)	(424,226)	(154,49)	(231,434)	(36,50)	(65,23)	(46,442)	(356,186)
249-256	(163,60)	(217,462)	(264,453)	(0,172)	(326,35)	(376,220)	(454,455)	(262,459)

In the proposed work, we present three approaches to reduce the number of conversions, each approach is an advanced version of the previous method. The basic methods can reduce just 25% of improvements, Partial developments decline in second strategy and 85% reduction in the third approach. These approaches are analyzed regarding power dissipation which is associated with many changes. The power dissipation in the NI is given in equation (9)

$$p = [NIT_{0to\,1}(C_s + C_l) + T_c\,C_c]V_{dd}^2 f_{clock} \quad (9)$$

Where $NIT_{0to\,1}$ is the total number of changes in the transmitted information, the substrate capacitance is denoted by Cs, the coupling capacitance represented by Cc, the heap capacitance Cl and f_{clock} is the information clock repetition. The coupling capacitance Cc causes power dissipation and following any one of the conditions leads to the improvement of Cc.

1. Developments occur when one of the CMOS switches is in condition state and the others are unchanged.

2. Transitions occur when one of the CMOS changes from 0 to 1 while the others switch from 1 to 0.

3.At the point when both switches changes at the same time

4. At the point when both switches do not change their states.

Consequently change in Cc is T_{Cc} is a weighted total of various states of coupling advances and it can be compose as appeared in condition (10)

$$T_{C_c} = W_1T_1 + W_2T_2 + W_3T_3 + W_4T_4 \quad (10)$$

Where T_1, T_2, T_3 and T_4 are the transitions for different condition, W_1, W_2, W_3 and W_4 are weights of their corresponding conditions and the following are the example of all four conditions

T_1: 00 11 or 01 10 T_2: 00 11
10 01 11 00 11 00
T_3: 00 11 01 10 T_4: 01 10
00 11 01 10 10 01

The number of transitions from 0 to 1for two consecutive Flits is counted

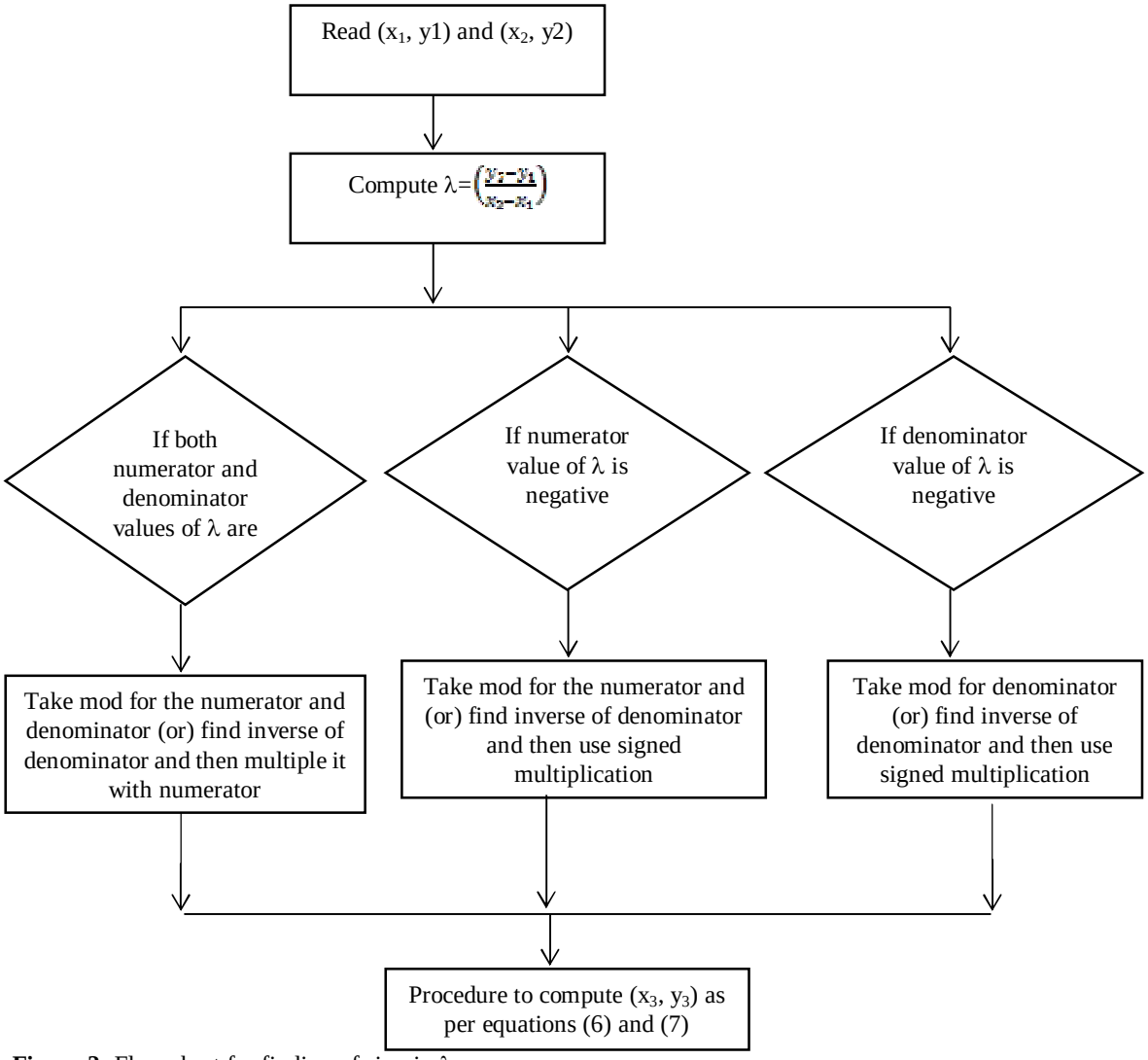

Figure 2: Flow chart for finding of sign in λ

3. NOVEL PUBLIC-KEY ENCRYPTION

The generated point from point addition and point doubling is encrypted using ECC- Elgamal algorithm for all 256 elliptical points to increase the security level. The proposed encryption is also reduces the power reduction before transmission through protocol and store in the cloud. The encryption process of the ECC- Elgamal algorithm is as follows:

Fix a finite cyclic group G i.e. $G=(Z_p)^*$ of order n for the fixed generator g in G i.e $G=\{1, g,g^2,g^3,\ldots,g^{n-1}\}$. For encryption, the secrete key is output of the eqn (8) which is used for sender and same key used for receiver. The encryption process is given in the eqn (11)

$E_p = data^G$ ----(11) and

cipher text is $c_t = E_{p^*}$ Key $_{\text{special characters}}$----------(12)

Using eqn (11) and (12), the original data is encrypted for all generated point from point addition and point doubling and resultants vales are uploaded into cloud for storage.

3.1 NOVEL PUBLIC-KEY DECRYPTION

Read the encrypted data from cloud and decrypt using ECC-Elgamal algorithm which is used same symmetrical key. The decrypted data is analyzed for calculation of the simulation time, throughput, and computational time.

Decryption process

Input: Data from cloud which encrypted by ECC-Elgamal algorithm and Key $_{\text{special characters}}$

Output: Reconstructed data

Step-1 Read secrete key form the memory

Step-2 Compute G^g and derive symmetric key k and compute c=kg $^{\text{Key special characters}}$

Step-2 Perform G^g- kg $^{\text{Key special characters}}$

Step-3 Calculate throughput in GHz

4. RESULTS AND DISCUSSION

Encryption is characterized as the way toward conversion of original information into a integer information to increase the security level in this research work. The ECC with Elgamal is advanced technique for more efficient and less computational mathematical operations in cloud security, which gives the security dependent on the hardness of different issues. This system constructs up a comparable security with limited expense. The quality of this proposed algorithm is, it completely relies upon the key and in alphabetical values table shown in Table.2. Additionally, it gives better response for the original information, and it empowers the secure transmission of keys between the transmitter and receivers. Typically, the ECC-Holomorphic-Elgamal algorithm accomplishments the operations of the computational includes Point doubling and point addition on the data and, it performs some addition and modulo operations on the encrypted data. Moreover, it is the most appropriate solution for taking care of the original information protection issues in cloud as shown in Fig.3.

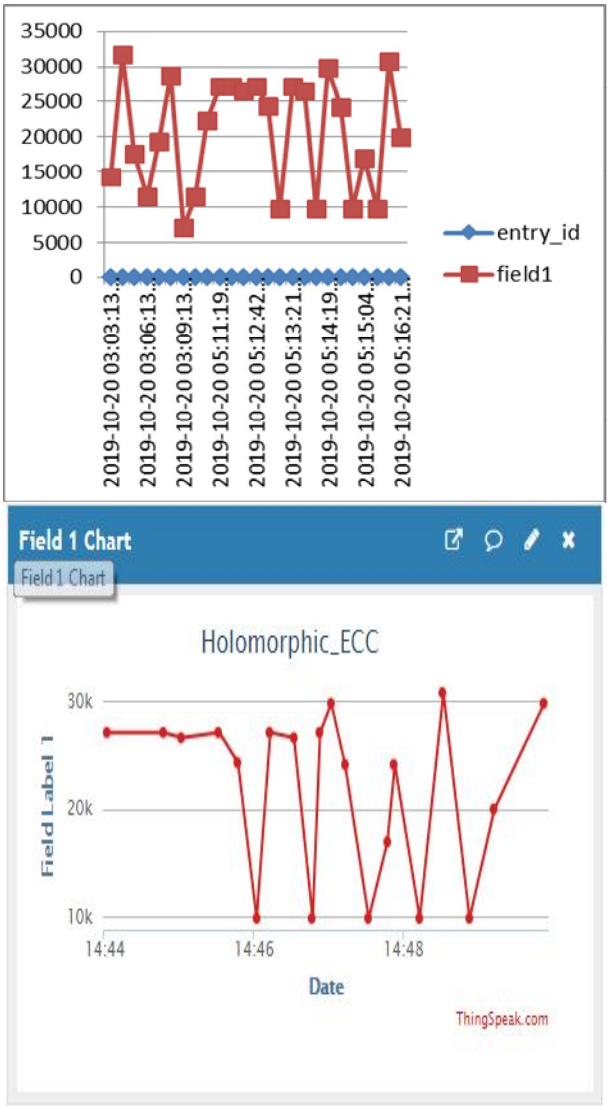

Figure 3: Encrypted data storages in Cloud in form the graph.

After downloading the stored data from the cloud through request process, the ECC-Elgamal decryption process is performed to retrieve the original data. In this stage of decryption, ECC and Reverse process of Elgamal process is extracts the cipher text values from the cloud which is already encrypted data, then the ECC with decrypt Elgamal algorithm is applied to convert back it into original and plotted in the form EEG/ECG and Image format with same secrete key which is used for encryption process. After access of the data from the cloud, the data is decrypted by using the point on curve, and the Holomorphic operations are applied on the data for generating the original text as shown in Fig.4.

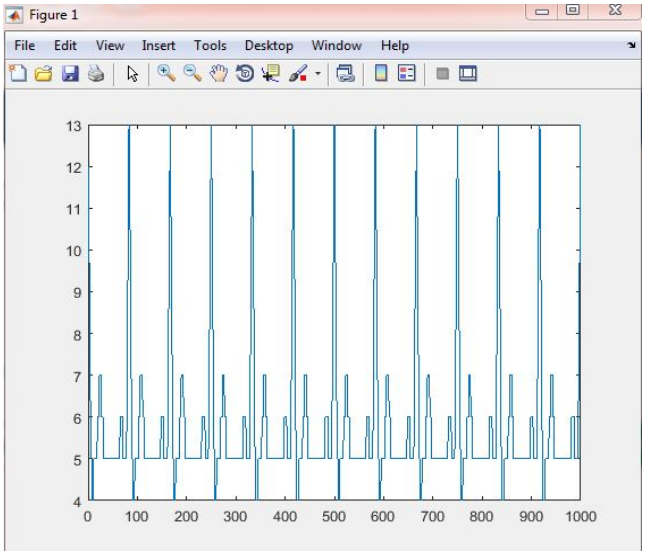

Figure 4: Simulated ECG signal after filtering

Table 2: Comparison between proposed work and previously published work

Parameter	Proposed	Existing
Execution time	230ms	314ms[31]
Throughput	0.2866 GHz	0.189GHz[33]
packet delivery ratio	451MHz	395MHz[34]

5. CONCLUSION AND DISCUSSION

The proposed new technique for cryptography is more feasible until speed, security, power, and complexity since the structure employs just XOR and straightforward experimental operation which uses fewer equipment resources. The bit process operation for both encoder and decoder is reduced, in some of the applications such as NoC and SoC chips power is used as a part of wired and remote communication for rapid switching activity between any two-information transmission and gathering. The ECCHE for encoder and decoder are primarily reduced, the power consumption and ECCHE are combined with ECC for exceptional secret keys to encode and decode the ongoing information via wired or remote system channels.

The proposed configuration is tried in Matlab 2017a. To address the confinements of the previous work another system is produced for assuring the security and protection of the information put away in cloud. This structure incorporates three modules, access policy control, encryption and decoding. Likewise, it includes the elements like information proprietor (college administrator), CSP, and information client. From the outset, the information user encrypts the information by applying ECCHE algorithm, and stores it on the cloud server. From that point onward, the information client can give the access control to get to the information put away in cloud. The proposed design is confirms the entrance control approach of the mentioned client for empowering the limited access on the information. Here, the private and open keys utilized for information encryption are produced by choosing the 4-piece irregular whole numbers. During encryption, the quadratic key components are figured and the arbitrary number is considered as the commotion. From that point forward, the Holomorphic tasks are understood expansion and increase are performed on the figure information. Once, the mentioned client gets the information, the decoding calculation is applied to change the figure information into the first information.

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