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Early Detection of Seizure episode in a known case of seizure disorder using WSN

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Abstract: A seizure (from the Latin sacire, "to take possession of") is a transient occurrence of signs or symptoms due to abnormal excessive or synchronous neuronal activity in the brain. Depending on the distribution of discharges, this abnormal brain activity can have various manifestations, ranging from dramatic convulsive activity to experiential phenomena not readily discernible by an observer. Although a variety of factors influence the incidence and prevalence of seizures, ~5–10% of the population will have at least one seizure, with the highest incidence occurring in early childhood and late adulthood.
The meaning of the term seizure needs to be carefully distinguished from that of epilepsy. Epilepsy describes a condition in which a person has a risk of recurrent seizures due to a chronic, underlying process. This definition implies that a person with a single seizure, or recurrent seizures due to correctable or avoidable circumstances, does not necessarily have epilepsy (although a single seizure associated with particular clinical or electroencephalographic features may establish the diagnosis of epilepsy). Epilepsy refers to a clinical phenomenon rather than a single disease entity, because there are many forms and causes of epilepsy. However, among the many causes of epilepsy there are various epilepsy syndromes in which the clinical and pathologic characteristics are distinctive and suggest a specific underlying etiology.
Using the definition of epilepsy as two or more unprovoked seizures, the incidence of epilepsy is ~0.3–0.5% in different populations throughout the world, and the prevalence of epilepsy has been estimated at 5–30 persons per 1000. A standout amongst the most intriguing uses of WSN is wellbeing observing. In this paper we presented a checking framework dependent on WSN for discovery of epilepsy seizures. This framework can be utilized for patients living in a clinical situation or at their home, where they do just their every day schedule.

I. INTRODUCTION

A. *Classification Of Seizures*

Determining the type of seizure that has occurred is essential for focusing the diagnostic approach on particular etiologies, selecting the appropriate therapy, and providing potentially vital information regarding prognosis. The International League Against Epilepsy (ILAE) Commission on Classification and Terminology provided an updated approach to classification of seizures in 2017. This system is based on the clinical features of seizures and associated electroencephalographic findings. Other potentially distinctive features such as etiology or cellular substrate are not considered in this classification system, although this will undoubtedly change in the future as more is learned about the pathophysiologic mechanisms that underlie specific seizure types.
A fundamental principle is that seizures may be either focal or generalized. *Focal seizures* originate within networks limited to one brain region (note that the term *partial seizures* is no longer used). *Generalized seizures* arise within and rapidly engage networks distributed across both cerebral hemispheres. Focal seizures are usually associated with structural abnormalities of the brain. In contrast, generalized seizures may result from cellular, biochemical, or structural abnormalities that have a more widespread distribution. There are clear exceptions in both cases, however.

B. *Focal Onset Seizures*

Focal seizures arise from a neuronal network either discretely localized within one brain region or more broadly distributed but still within a cerebral hemisphere. With the new classification system, the subcategories of "simple focal seizures" and "complex focal seizures" have been eliminated. Instead, the classification emphasizes the effect on awareness (intact or impaired) and nature of the onset (motor or nonmotor). Focal seizures can also evolve into generalized seizures. In the past this was referred to as *focal seizures with secondary generalization*, but the new system relies on descriptions of the type of generalized seizures that evolve from the focal seizure. The routine interictal (i.e., between seizures) electroencephalogram (EEG) in patients with focal seizures is often normal or may show brief discharges termed *epileptiform spikes*, or *sharp waves*. Because focal seizures can arise from the medial temporal lobe or inferior frontal lobe (i.e., regions distant from the scalp), the EEG recorded during the seizure may be nonlocalizing. However, the region of seizure onset may be detected using surgically placed intracranial electrodes.

Focal Seizures with Intact Awareness Focal seizures can have motor manifestations (such as tonic, clonic, or myoclonic movements) or nonmotor manifestations (such as sensory, autonomic, or emotional symptoms) without impairment of awareness. For example, a patient having a focal motor seizure arising from the right primary motor cortex near the area controlling hand movement will note the onset of involuntary movements of the contralateral, left hand. Since the cortical region controlling hand movement is immediately adjacent to the region for facial expression, the seizure may also cause abnormal movements of the face synchronous with the movements of the hand. The EEG recorded with scalp electrodes during the seizure (i.e., an ictal EEG) may show abnormal discharges in a very limited region over the appropriate area of cerebral cortex if the seizure focus involves the cerebral convexity.

Three additional features of focal motor seizures are worth noting. First, in some patients, the abnormal motor movements may begin in a very restricted region such as the fingers and gradually progress (over seconds to minutes) to include a larger portion of the extremity. This phenomenon, described by Hughlings Jackson and known as a "Jacksonian march," represents the spread of seizure activity over a progressively larger region of motor cortex. Second, patients may experience a localized paresis (Todd's paralysis) for minutes to many hours in the involved region following the seizure. Third, in rare instances, the seizure may continue for hours or days. This condition, termed *epilepsia partialis continua*, is often refractory to medical therapy.

Focal seizures may also manifest as changes in somatic sensation (e.g., paresthesias), vision (flashing lights or formed hallucinations), equilibrium (sensation of falling or vertigo), or autonomic function 3051
(flushing, sweating, piloerection). Focal seizures arising from the temporal or frontal cortex may also cause alterations in hearing, olfaction, or emotional state. This includes the sensation of unusual, intense odors (e.g., burning rubber or kerosene) or sounds (crude or highly complex sounds), or an epigastric sensation that rises from the stomach or chest to the head. Some patients describe odd, internal feelings such as fear, a sense of impending change, detachment, depersonalization, déjá vu, or illusions that objects are growing smaller (micropsia) or larger (macropsia). These subjective, "internal" events that are not directly observable by someone else are referred to as *auras*.

Focal Seizures with Impaired Awareness Focal seizures may also be accompanied by a transient impairment of the patient's ability to maintain normal contact with the environment. The patient is unable to respond appropriately to visual or verbal commands during the seizure and has impaired recollection or awareness of the ictal phase. The seizures frequently begin with an aura (i.e., a focal seizure without cognitive disturbance) that is stereotypic for the patient. The start of the ictal phase is often a motionless stare, which marks the onset of the period of impaired awareness. The impaired awareness is usually accompanied by *automatisms*, which are involuntary, automatic behaviors that have a wide range of manifestations. Automatisms may consist of very basic behaviors such as chewing, lip smacking, swallowing, or "picking" movements of the hands, or more elaborate behaviors such as a display of emotion or running. The patient is typically confused following the seizure, and the transition to full recovery of consciousness may range from seconds up to an hour or longer. Examination immediately following the seizure may show an anterograde amnesia or transient neurological deficits (such as aphasia, hemi-neglect, or visual loss) caused by postictal inhibition of the cortical regions most involved in the seizure itself.

The range of potential clinical behaviors linked to focal seizures is so broad that extreme caution is advised before concluding that stereotypic episodes of bizarre or atypical behavior are not due to seizure activity. In such cases additional, detailed EEG studies may be helpful.

C. Evolution Of Focal Seizures To Generalized Seizures

Focal seizures can spread to involve both cerebral hemispheres and produce a generalized seizure, usually of the tonic-clonic variety (discussed below).

This evolution is observed frequently following focal seizures arising from a region in the frontal lobe, but may also be associated with focal seizures occurring elsewhere in the brain. A focal seizure that evolves into a generalized seizure is often difficult to distinguish from a primary generalized onset tonic-clonic seizure, because bystanders tend to emphasize the more dramatic, generalized convulsive phase of the seizure and overlook the more subtle, focal symptoms present at onset. In some cases, the focal onset of the seizure becomes apparent only when a careful history identifies a preceding aura. Often, however, the focal onset is not clinically evident and may be established only through careful EEG analysis. Nonetheless, distinguishing between these two entities is extremely important, because there may be substantial differences in the evaluation and treatment of epilepsies characterized by focal versus generalized onset seizures.

D. Generalized Onset Seizures

Generalized seizures arise at some point in the brain but immediately and rapidly engage neuronal networks in both cerebral hemispheres. Several types of generalized seizures have features that place them in distinctive categories and facilitate clinical diagnosis.

Typical Absence Seizures Typical absence seizures are characterized by sudden, brief lapses of consciousness without loss of postural control. The seizure usually lasts for only seconds, consciousness returns as suddenly as it was lost, and there is no postictal confusion. Although the brief loss of consciousness may be clinically inapparent or the sole manifestation of the seizure discharge, absence seizures are usually accompanied by subtle, bilateral motor signs such as rapid blinking of the eyelids, chewing movements, or small-amplitude, clonic movements of the hands.

Typical absence seizures are associated with a group of genetically determined epilepsies with onset usually in childhood (ages 4–10 years) or early adolescence and are the main seizure type in 15–20% of children with epilepsy. The seizures can occur hundreds of times per day, but the child may be unaware of or unable to convey their existence. Because the clinical signs of the seizures are subtle, especially to parents who may not have had previous experience with seizures, it is not surprising that the first clue to absence epilepsy is often unexplained “daydreaming” and a decline in school performance recognized by a teacher.

The electrophysiologic hallmark of typical absence seizures is a generalized, symmetric, 3-Hz spike-and-slow-wave discharges that begins and ends suddenly, superimposed on a normal EEG background. Periods of spike-and-slow-wave discharges lasting more than a few seconds usually correlate with clinical signs, but the EEG often shows many more brief bursts of abnormal cortical activity than were suspected clinically. Hyperventilation tends to provoke these electrographic discharges and even the seizures themselves and is routinely used when recording the EEG.

Atypical Absence Seizures Atypical absence seizures have features that deviate both clinically and electrophysiologically from typical absence seizures. For example, the lapse of consciousness is usually of longer duration and less abrupt in onset and cessation, and the seizure is accompanied by more obvious motor signs that may include focal or lateralizing features. The EEG shows a generalized, slow spike-and-slow-wave pattern with a frequency of $\leq$2.5 per second, as well as other abnormal activity. Atypical absence seizures are usually associated with diffuse or multifocal structural abnormalities of the brain and therefore may accompany other signs of neurologic dysfunction such as mental retardation. Furthermore, the seizures are less responsive to anticonvulsants compared to typical absence seizures.

Generalized, Tonic-Clonic Seizures Generalized onset tonic-clonic seizures are the main seizure type in ~10% of all persons with epilepsy. They are also the most common seizure type resulting from metabolic derangements and are therefore frequently encountered in many different clinical settings. The seizure usually begins abruptly without warning, although some patients describe vague premonitory symptoms in the hours leading up to the seizure. This prodrome is distinct from the stereotypic auras associated with focal seizures that generalize. The initial phase of the seizure is usually tonic contraction of muscles throughout the body, accounting for a number of the classic features of the event. Tonic contraction of the muscles of expiration and the larynx at the onset will produce a loud moan or “ictal cry.” Respirations are impaired, secretions pool in the oropharynx, and cyanosis develops. Contraction of the jaw muscles may cause biting of the tongue. A marked enhancement of sympathetic tone leads to increases in heart rate, blood pressure, and pupillary size. After 10–20 s, the tonic phase of the seizure typically evolves into the clonic phase, produced by the superimposition of periods of muscle relaxation on the tonic muscle contraction. The periods of relaxation progressively increase until the end of the ictal phase, which usually lasts no more than 1 min. The postictal phase is characterized by unresponsiveness, muscular flaccidity, and excessive salivation that can cause stridorous breathing and partial airway obstruction. Bladder or bowel incontinence may occur at this point. Patients gradually regain consciousness over minutes to hours, and during this transition, there is typically a period of postictal confusion. Patients subsequently complain of headache, fatigue, and muscle ache that can last for many hours. The duration of impaired consciousness in the postictal phase can be extremely long (i.e., many hours) in patients with prolonged seizures or underlying central nervous system (CNS) diseases such as alcoholic cerebral atrophy.

The EEG during the tonic phase of the seizure shows a progressive increase in generalized low-voltage fast activity, followed by generalized high-amplitude, polyspike discharges. In the clonic phase, the high-amplitude activity is typically interrupted by slow waves to create a spike-and-slow-wave pattern. The postictal EEG shows diffuse suppression of all cerebral activity, then slowing that gradually recovers as the patient awakens.

There are a number of variants of generalized motor seizures, including pure tonic and pure clonic seizures. Brief tonic seizures lasting only a few seconds are especially noteworthy since they are usually associated with specific epilepsy syndromes having mixed seizure phenotypes, such as the Lennox-Gastaut syndrome (discussed below).

Atonic Seizures Atonic seizures are characterized by sudden loss of postural muscle tone lasting 1–2 s. Consciousness is briefly impaired, but there is usually no postictal confusion. A very brief seizure may cause only a quick head drop or nodding movement, whereas a longer seizure will cause the patient to collapse. This can be extremely dangerous, because there is a substantial risk of direct head injury with the fall. The EEG shows brief, generalized spike-and-wave discharges followed immediately by diffuse slow waves that correlate with the loss of muscle tone. Similar to pure tonic seizures, atonic seizures are usually seen in association with known epilepsy syndromes.

Myoclonic Seizures Myoclonus is a sudden and brief muscle contraction that may involve one part of the body or the entire body. A normal, common physiologic form of myoclonus is the sudden jerking movement observed while falling asleep. Pathologic myoclonus is most commonly seen in association with metabolic disorders, degenerative CNS diseases, or anoxic brain injury (Chap. 301). Although the distinction from other forms of myoclonus is imprecise, myoclonic seizures are considered to be true epileptic events because they are caused by cortical (versus subcortical or spinal) dysfunction. The EEG shows bilaterally synchronous spike-and-slow-wave discharges immediately prior to the movement and muscle artifact associated with the myo-clonus. Myoclonic seizures usually coexist with other forms of generalized seizures but are the predominant feature of juvenile myoclonic epilepsy (JME) (discussed below).

Epileptic Spasms Epileptic spasms are characterized by a briefly sustained flexion or extension of predominantly proximal muscles, including truncal muscles. The EEG usually shows hypsarrhythmia, which consist of diffuse, giant slow waves with a chaotic background of irregular, multifocal spikes and sharp waves. During the clinical spasm, there is a marked suppression of the EEG background (the “electrodecremental response”). The electromyogram (EMG) also reveals a characteristic rhomboid pattern that may help distinguish spasms from brief tonic and myoclonic seizures. Epileptic spasms occur predominantly in infants and likely result from differences in neuronal function and connectivity in the immature versus mature CNS.

E. Epilepsy Syndromes

Epilepsy syndromes are disorders in which epilepsy is a predominant feature, and there is sufficient evidence (e.g., through clinical, EEG, radiologic, or genetic observations) to suggest a common underlying mechanism. Three important epilepsy syndromes are listed below; additional examples with a known genetic basis are shown in **Table 418-2**.

F. Juvenile Myoclonic Epilepsy

JME is a generalized seizure disorder of unknown cause that appears in early adolescence and is usually characterized by bilateral myoclonic jerks that may be single or repetitive. The myoclonic seizures are most frequent in the morning after awakening and can be provoked by sleep deprivation. Consciousness is preserved unless the myoclonus is especially severe. Many patients also experience generalized tonic-clonic seizures, and up to one-third have absence seizures. Although complete remission is relatively uncommon, the seizures usually respond well to appropriate anticonvulsant medication. There is often a family history of epilepsy, and genetic linkage studies suggest a polygenic cause.

G. Lennox-Gastaut Syndrome

Lennox-Gastaut syndrome occurs in children and is defined by the following triad: (1) multiple seizure types (usually including generalized tonic-clonic, atonic, and atypical absence seizures); (2) an EEG showing slow (<3 Hz) spike-and-wave discharges and a variety of other abnormalities; and (3) impaired cognitive function in most but not all cases.

3053 Lennox-Gastaut syndrome is associated with CNS disease or dysfunction from a variety of causes, including *de novo* mutations, developmental abnormalities, perinatal hypoxia/ischemia, trauma, infection, and other acquired lesions. The multifactorial nature of this syndrome suggests that it is a nonspecific response of the brain to diffuse neuronal dysfunction. Unfortunately, many patients have a poor prognosis due to the underlying CNS disease and the physical and psychosocial consequences of severe, poorly controlled epilepsy.

H. Mesial Temporal Lobe Epilepsy Syndrome

Mesial temporal lobe epilepsy (MTLE) is the most common syndrome associated with focal seizures with impairment of consciousness and is an example of an epilepsy syndrome with distinctive clinical, electroencephalographic, and pathologic features. High-resolution magnetic resonance imaging (MRI) can detect the characteristic hippocampal sclerosis that appears to be essential in the pathophysiology of MTLE for many patients. Recognition of this syndrome is especially important because it tends

to be refractory to treatment with anticonvulsants but responds well to surgical intervention. Advances in the understanding of basic mechanisms of epilepsy have come through studies of experimental models of MTLE, discussed below.

Causes of Seizures	
Neonates (<1 month)	Perinatal hypoxia and ischemia
	Intracranial hemorrhage and trauma
	CNS infection
	Metabolic disturbances (hypoglycemia, hypocalcemia, hypomagnesemia, pyridoxine deficiency)
	Drug withdrawal
	Developmental disorders
	Genetic disorders
Infants and children (>1 month and <12 years)	Febrile seizures
	Genetic disorders (metabolic, degenerative, primary epilepsy syndromes)
	CNS infection
	Developmental disorders
	Trauma
Adolescents (12–18 years)	Trauma
	Genetic disorders
	Infection
	Illicit drug use
	Brain tumor
Young adults (18–35 years)	Trauma
	Alcohol withdrawal
Illicit drug use	
Brain tumor	
Autoantibodies	
Older adults (>35 years)	Cerebrovascular disease
Brain tumor	
Alcohol withdrawal	
Metabolic disorders (uremia, hepatic failure, electrolyte abnormalities, hypoglycemia, hyperglycemia)	
Alzheimer's disease and other degenerative CNS diseases	
Autoantibodies	

Abbreviation: CNS, central nervous system.

II. EXISTING SYSTEM

A. *Approach To The Patient*

1) *Seizure:* When a patient presents shortly after a seizure, the first priorities are attention to vital signs, respiratory and cardiovascular support, and treatment of seizures if they resume (see "Treatment: Seizures and Epilepsy"). Life-threatening conditions such as CNS infection, metabolic derangement, or drug toxicity must be recognized and managed appropriately. When the patient is not acutely ill, the evaluation will initially focus on whether there is a history of earlier seizures. If this is the first seizure, then the emphasis will be to: (1) establish whether the reported episode was a seizure rather than another paroxysmal event, (2) determine the cause of the seizure by identifying risk factors and precipitating events, and (3) decide whether anticonvulsant therapy is required in addition to treatment for any underlying illness. In the patient with prior seizures or a known history of epilepsy, the evaluation is directed toward: (1) identification of the underlying cause and precipitating factors, and (2) determination of the adequacy of the patient's current therapy.

B. History And Examination

The first goal is to determine whether the event was truly a seizure. An in-depth history is essential, because *in many cases the diagnosis of a seizure is based solely on clinical grounds—the examination and laboratory studies are often normal.* Questions should focus on the symptoms before, during, and after the episode in order to differentiate a seizure from other paroxysmal events (see "Differential Diagnosis of Seizures" below). Seizures frequently occur out-of-hospital, and the patient may be unaware of the ictal and immediate postictal phases; thus, witnesses to the event should be interviewed carefully.

The history should also focus on risk factors and predisposing events. Clues for a predisposition to seizures include a history of febrile seizures, a family history of seizures, and, of particular importance, earlier auras or brief seizures not recognized as such. Epileptogenic factors such as prior head trauma, stroke, tumor, or CNS infection should be identified. In children, a careful assessment of developmental milestones may provide evidence for underlying CNS disease. Precipitating factors such as sleep deprivation, systemic diseases, electrolyte or metabolic derangements, acute infection, drugs that lower the seizure threshold, or alcohol or illicit drug use should also be identified.

The general physical examination includes a search for signs of infection or systemic illness. Careful examination of the skin may reveal signs of neurocutaneous disorders such as tuberous sclerosis or neurofibromatosis, or chronic liver or renal disease. A finding of organomegaly may indicate a metabolic storage disease, and limb asymmetry may provide a clue to brain injury early in development. Signs of head trauma and use of alcohol or illicit drugs should be sought. Auscultation of the heart and carotid arteries may identify an abnormality that predisposes to cerebrovascular disease.

All patients require a complete neurologic examination, with particular emphasis on eliciting signs of cerebral hemispheric disease. Careful assessment of mental status (including memory, language function, and abstract thinking) may suggest lesions in the anterior frontal, parietal, or temporal lobes. Testing of visual fields will help screen for lesions in the optic pathways and occipital lobes. Screening tests of motor function such as pronator drift, deep tendon reflexes, gait, and coordination may suggest lesions in motor (frontal) cortex, and cortical sensory testing (e.g., double simultaneous stimulation) may detect lesions in the parietal cortex.

C. Laboratory Studies

Routine blood studies are indicated to identify the more common metabolic causes of seizures such as abnormalities in electrolytes, glucose, calcium, or magnesium, and hepatic or renal disease. A screen for toxins in blood and urine should also be obtained from all patients in appropriate risk groups, especially when no clear precipitating factor has been identified. A lumbar puncture is indicated if there is any suspicion of meningitis or encephalitis, and it is mandatory in all patients infected with HIV, even in the absence of symptoms or signs suggesting infection. Testing for autoantibodies in the serum and cerebrospinal fluid (CSF) should be considered in patients presenting with a seemingly aggressive form of epilepsy associated with other abnormalities such as psychiatric symptoms or cognitive disturbances.

D. Electrophysiologic Studies

The electrical activity of the brain (the EEG) is easily recorded from electrodes placed on the scalp. The potential difference between pairs of electrodes on the scalp (bipolar derivation) or between individual scalp electrodes and a relatively inactive common reference point (referential derivation) is amplified and displayed on a computer monitor, oscilloscope, or paper. Digital systems allow the EEG to be reconstructed and displayed with any desired format and to be manipulated for more detailed analysis and also permit computerized techniques to be used to detect certain abnormalities. The characteristics of the normal EEG depend on the patient's age and level of arousal. The rhythmic activity normally recorded represents the postsynaptic potentials of vertically oriented pyramidal cells of the cerebral cortex and is characterized by its frequency. In normal awake adults lying quietly with the eyes closed, an 8- to 13-Hz alpha rhythm is seen posteriorly in the EEG, intermixed with a variable amount of generalized faster (beta) activity (>13 Hz); the alpha rhythm is attenuated when the eyes are opened. During drowsiness, the alpha rhythm is also attenuated; with light sleep, slower activity in the theta (4–7 Hz) and delta (<4 Hz) ranges becomes more conspicuous.

All patients who have a possible seizure disorder should be evaluated with an EEG as soon as possible. In the evaluation of a patient with suspected epilepsy, the presence of *electrographic seizure activity* during the clinically evident event (i.e., abnormal, repetitive, rhythmic activity having a discrete onset and termination) clearly establishes the diagnosis. The absence of electrographic seizure activity does not exclude a seizure disorder, however, because focal seizures may originate from a region of the cortex that cannot be detected by standard scalp electrodes. The EEG is always abnormal during generalized tonic-clonic seizures. Because seizures are typically infrequent and unpredictable, it is often not possible to obtain the EEG during a clinical event. In such situations, activating procedures are generally undertaken while the EEG is recorded in an attempt to provoke abnormalities. These procedures

commonly include hyperventilation (for 3 or 4 min), photic stimulation, sleep, and sleep deprivation on the night prior to the recording. Continuous monitoring for prolonged periods in video-EEG telemetry units for hospitalized patients or the use of portable equipment to record the EEG continuously for ≥24 h in ambulatory patients has made it easier to capture the electrophysiologic accompaniments of clinical events. In particular, video-EEG telemetry is now a routine approach for the accurate diagnosis of epilepsy in patients with poorly characterized events or seizures that are difficult to control.

The EEG may also be helpful in the interictal period by showing certain abnormalities that are highly supportive of the diagnosis of epilepsy. Such *epileptiform activity* consists of bursts of abnormal discharges containing spikes or sharp waves. The presence of epileptiform activity is not entirely specific for epilepsy, but it has a much greater prevalence in patients with epilepsy than in normal individuals. However, even in an individual who is known to have epilepsy, the initial routine interictal EEG may be normal up to 60% of the time. Thus, the EEG cannot establish the diagnosis of epilepsy in many cases.

The EEG is also used for classifying seizure disorders and aiding in the selection of anticonvulsant medications. For example, episodic generalized spike-wave activity is usually seen in patients with typical absence epilepsy and may be seen with other generalized epilepsy syndromes. Focal interictal epileptiform discharges would support the diagnosis of a focal seizure disorder such as temporal lobe epilepsy or frontal lobe seizures, depending on the location of the discharges.

The routine scalp-recorded EEG may also be used to assess the prognosis of seizure disorders; in general, a normal EEG implies a better prognosis, whereas an abnormal background or profuse epileptiform activity suggests a worse outcome. Unfortunately, the EEG has not proved to be useful in predicting which patients with predisposing conditions such as head injury or brain tumor will go on to develop epilepsy, because in such circumstances epileptiform activity is commonly encountered regardless of whether seizures occur.

Magnetoencephalography (MEG) provides another way of looking noninvasively at cortical activity. Instead of measuring electrical activity of the brain, it measures the small magnetic fields that are generated by this activity. The source of epileptiform activity seen on MEG can be analyzed, and its source in the brain can be estimated using a variety of mathematical techniques. These source estimates can then be plotted on an anatomic image of the brain such as an MRI (discussed below) to generate a magnetic source image (MSI). MSI can be useful to localize potential seizure foci.

E. Brain Imaging

Almost all patients with new-onset seizures should have a brain imaging study to determine whether there is an underlying structural abnormality that is responsible. The only potential exception to this rule is children who have an unambiguous history and examination suggestive of a benign, generalized seizure disorder such as absence epilepsy. MRI has been shown to be superior to computed tomography (CT) for the detection of cerebral lesions associated with epilepsy. In some cases, MRI will identify lesions such as tumors, vascular malformations, or other pathologies that need urgent therapy. The availability of newer MRI methods such as 3-tesla scanners, parallel imaging with multichannel head coils, three-dimensional structural imaging at submillimeter resolution, and widespread use of pulse sequences such as fluid-attenuated inversion recovery (FLAIR), has increased the sensitivity for detection of abnormalities of cortical architecture, including hippocampal atrophy associated with mesial temporal sclerosis, as well as abnormalities of cortical neuronal migration. In such cases, the findings may not lead to immediate therapy, but they do provide an explanation for the patient's seizures and point to the need for chronic antiepileptic drug therapy or possible surgical resection.

In the patient with a suspected CNS infection or mass lesion, CT scanning should be performed emergently when MRI is not immediately available. Otherwise, it is usually appropriate to obtain an MRI study within a few days of the initial evaluation. Functional imaging procedures such as positron emission tomography (PET) and single-photon emission computed tomography (SPECT) are also used to evaluate certain patients with medically refractory seizures (discussed below).

F. Genetic Testing

With the increasing recognition of specific gene mutations causing epilepsy, genetic testing is beginning to emerge as part of the diagnostic evaluation of patients with epilepsy. In addition to providing a definitive diagnosis (which may be of great benefit to the patient and family members, and curtail the pursuit of additional, unrevealing laboratory testing), genetic testing may offer a guide for therapeutic options (see section "Selection of Antiepileptic Drugs" below). Presently, genetic testing is being done mainly in infants and children with epilepsy syndromes thought to have a genetic cause. However, genetic testing should also be considered in older patients with a history suggesting an undiagnosed genetic epilepsy syndrome that began early in life.

III. IoT (INTERNET Of THINGS)

[2]The IoT is a broadly utilized term for a lot of advancements, frameworks, and plan standards related with the developing influx of Internet-associated things that depend on the physical condition. In numerous regards, it can at first look equivalent to M2M correspondence interfacing sensors and different gadgets to Information and Communication Technology (ICT) frameworks by means of wired or remote systems. As opposed to M2M, in any case, IoT additionally alludes to the association of such frameworks and sensors to the more extensive Internet, just as the utilization of general Web innovations. In the more drawn out term, it is conceived that an IoT biological system will rise not unlike the present Internet, permitting things and true articles to interface, convey, and collaborate with each other similarly people do by means of the web today. Expanded comprehension of the intricacy of the frameworks being referred to, economies of scale, and strategies for guaranteeing interoperability, related to key business drivers and administration structures crosswise over esteem chains, will make wide-scale reception also, arrangement of IoT arrangements. Never again will the Internet be just about individuals, media, and substance, in any case, it will likewise incorporate all certifiable resources as shrewd animals trading data, interfacing with individuals, supporting business forms of undertakings, and making learning. The IoT isn't another Internet, it is an augmentation to the current Internet. IoT is about the innovation, the remote checking, and control, and furthermore about where these innovations are connected. IoT can have an attention on the open creative guarantees of the advances at play, and furthermore on cutting edge and complex handling inside bound and close situations, for example, modern mechanization. While utilizing IoT advancements in increasingly shut conditions, an elective translation of IoT could then be "Intranet of Things." Dreams set forward (for example SENSEI 2013) have included ideas like a worldwide open texture of sensor and actuator benefits that incorporate various Remote Sensor Network (WSN) organizations and give diverse dimensions of totaled sensor and actuator benefits in an open way for application development and for use in not just unadulterated screen and control kind of applications, yet additionally to expand or enhance different sorts of administrations with logical data. IoT applications won't just depend on information and administrations from sensor and actuators alone. Similarly imperative is the mix in of other data sources that have pertinence from the perspective of the physical world. These can be information from Geographic Information Systems (GIS) like street databases and climate guaging frameworks, and can be of both a static nature and continuous nature. Indeed, even data removed from web based life like Twitter channels or Facebook notices that identify with genuine perceptions can be nourished into the equivalent IoT framework.

IoT architecture

1) *Stage 1 (Sensors/Actuators):* A thing in the context of “Internet of Things”, should be equipped with sensors and actuators thus giving the ability to emit, accept and process signals.

2) *Stage 2 (Data Acquisition Systems):* The data from the sensors starts in analogue form which needs to be aggregated and converted into digital streams for further processing. *Data acquisition systems* perform these data aggregation and conversion functions.

3) *Stage 3 (Edge Analytics):* Once IoT data has been digitized and aggregated, it may require further processing before it enters the data center, this is where Edge Analytics comes in.

4) *Stage 4 (Cloud Analytics):* Data that needs more in-depth processing gets forwarded to physical data centers or cloud-based systems.

IV. IoT IN DETECTING SEIZURES

[3]Epilepsy is a standout amongst the most widely recognized neurological disarranges, influencing right around 60 million individuals everywhere throughout the world. A large portion of the influenced individuals can be dealt with effectively with medication treatment (67%) or neurosurgical methodology (7%-8%). By and by 25% of the influenced individuals can't be treated by any accessible treatment. For stubborn patients who keep on having successive seizures, it has been appeared escalated observing with electroencephalogram (EEG) and video over an extensive stretch, adds to the administration of every day care and the change of medication treatment. The long haul observing with EEG and video can be unsavory for patients, and investigating a lot of EEG/video-information is exceptionally work escalated for therapeutic staff. Moreover, this technique can't yet be connected progressively methodology.

All the previously mentioned components have made it important to search for sensors that are tolerant well disposed and can be utilized for a solid programmed discovery of epileptic seizures. One of these sensors is the accelerometer. Accelerometers are utilized in numerous therapeutic research regions for action acknowledgment. For example, in Parkinson's disorder, considers go for recognizing obsessive (times of hypokinesia, bradykinesia and dyskinesia) and ordinary developments.

Here, we center around engine signs since epileptic seizures are regularly joined by engine signs. With accelerometry (ACM), just seizures that convey what needs be in developments or aggravate typical development examples can be recognized. A calculation is proposed dependent on HMM for seizure identification. The patient developments are demonstrated with Hidden Markov Models and Bayesian investigation of the flag is performed. Calculation of seizure discovery is without adjustment to quiet however this issue is defeated in Jallon P. A Bayesian methodology for epileptic seizures discovery with 3D accelerometers sensors. About

nighttime epileptic seizure, it centers around the refinement between seizure moves and nighttime moves. Sensors are along these lines joined on a patient and the creators propose to identify period with engine exercises.

Long haul home checking can give the nervous system specialist a target proportion of the quantity of seizures that a patient can have amid the day. Likewise in a portion of the substantial epileptic assaults the patient needs restorative consideration after or amid the seizure. Human body development can be checked through a remote system made out of inertial sensors. A seizure discovery framework is depicted dependent on Wireless Sensor Network (WSN) that can decide the area of the patient when a seizure is recognized and sends an alert to clinic staff or the patient's relatives.

V. PROPOSED SYSTEM

In this paper, we present a framework dependent on WSN that gives a consistent checking without constraining the opportunity and protection of the patients. The primary objective is to recognize information with and without seizure development.

The general limitations and attributes of the framework are recorded as pursues:

1) *Flexibility:* All outside wirings can be expelled to permit the subject under test move without limitations
2) *Ease of Utilization:* The system convention permits the sensor system to introduce itself in a very specially appointed, self-sorting out way
3) *Reliability:* While information unwavering quality is constantly vital, it turns into a basic prerequisite for some applications, for instance, in restorative observing
4) Biaxial speeding up estimation
5) Rechargeable batteries
6) Low control utilization
7) *Comfort ability:* The gadget has little size and low weight, and can be appended to various pieces of patient's body.

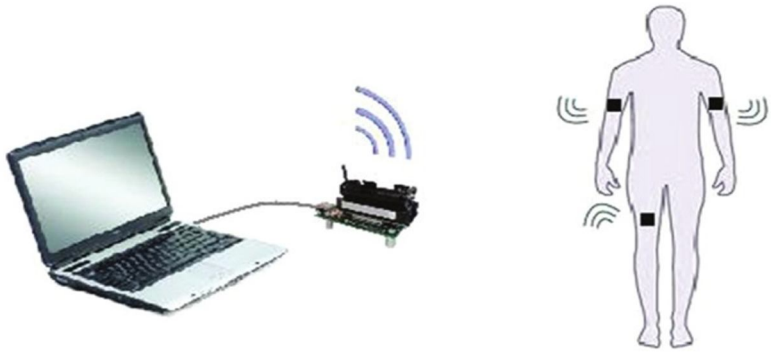
There are two sorts of hubs in the system:

Mobile sensor hubs which are set on the assortment of patients

Static hubs which are sited on fixed explicit areas at the structure.

The static hubs transport the gathered information from versatile sensor hubs to a base-station. The base-station sends information to PC server through a USB link. Recorded information will be prepared and when a seizure is identified, static hubs can decide roughly the area of the patient and sends an alert to medical clinic staff or the patient's relatives.

The investigation of the recorded information depends on counterfeit neural system (ANN) and K Nearest Neighbor (KNN) to perceive seizure developments from ordinary developments.



Seizure Detection Method

Figure 1: Proposed system for epileptic seizure detection

A. *Data Collecting*

Datasets from patients experiencing overwhelming epilepsy were utilized for the advancement of a programmed identification calculation. In this framework, three 2D accelerometer sensors were situated on the correct arm, left arm and left thigh of epileptic patients. Datasets were procured from three patients experiencing extreme epilepsy. The datasets of the epileptic patients were recorded amid the day. We recorded 20 epileptic seizures.

Patients were solicited to play out a grouping from regular ordinary exercises however were not advised extraordinarily how to do them. Typical exercises that we recorded included static exercises, for example, perusing, working with PC, brushing of teeth, and

lying and dynamic exercises, for example, strolling. The inspecting recurrence of the accelerometer is 3 Hz. Figure 2 demonstrates the unadulterated yield of accelerometers when examining recurrence is 3 Hz. It appears at first lying and afterward seizure flag. In this Figure the seizure has started from 180 examples. Quickening has been estimated dependent on gravity (g=9.8m/s2)

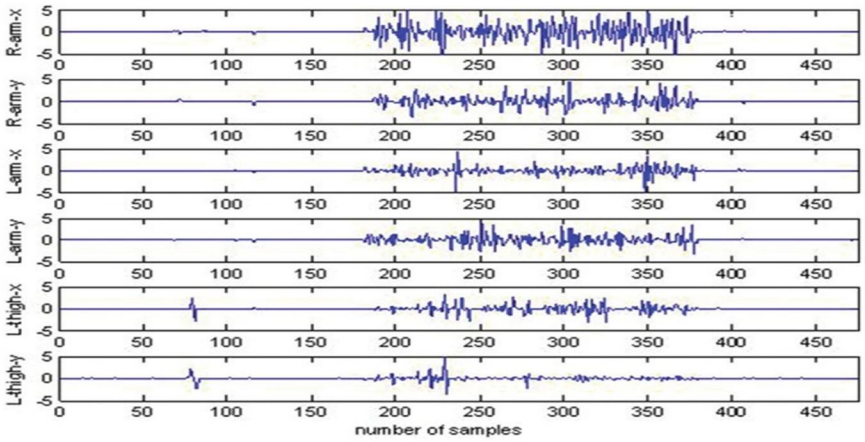


Figure 2: The pure output of accelerometers

For analysing and detecting seizures from this huge data sequence, the best way is cutting the acceleration sequences into many overlapping windows (segments) of the same length. For our data, the size of this window is considered 50 samples and it is repeated for every 25 samples. Since the sampling frequency is 3 Hz, we cut the data sequence every 9 seconds and analyzed this window of the ACM data to detect seizure. Figure 3 shows the acceleration data and overlapping window that located the signal.

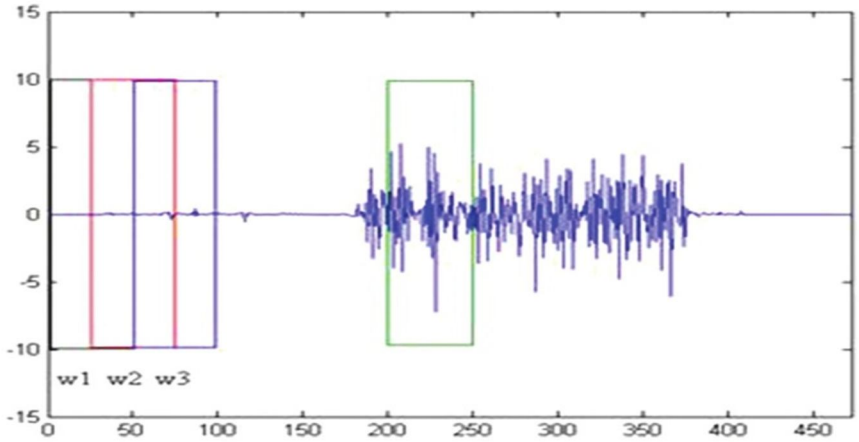


Figure 3: Acceleration data with overlapping windows

B. Preprocessing

The yield of an accelerometer connected to the human body comprises of various parts:

1) Noise from sensor and estimation framework
2) Noise sources from the earth: (an) increasing speeds created by outer sources like vehicles; (b) increasing speeds due to knocking of the sensor or the body against different articles
3) Noise sources from the body: (a) Muscle tremor; (b) Heart; (c) Respiration; (d) Blood stream
4) Gravitational increasing speed
5) Acceleration because of developments of the body

In contrast with body developments, the clamor from the sensor and estimation framework can be ignored. All information utilized in this investigation were recorded while the patients were in their living condition, in this way there were no increasing velocities created by outer sources.

At the point when there is no development, physiological irritations, similar to breath and pulse and gravitational increasing speed are unmistakable in the flag. A preprocessing step is executed on the crude information for erasing these perturbations.

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VI. CONCLUSION

A standout amongst the most intriguing uses of WSN is wellbeing observing. In this paper we presented a checking framework dependent on WSN for discovery of epilepsy seizures. This framework can be utilized for patients living in a clinical situation or at their home, where they do just their every day schedule. Our framework can decide the area of the patient when a seizure is identified and sends a caution to emergency clinic staff or the patient's relatives. Since our sensors are remote, the subject under test can move without confinements. Furthermore, as a result of the little size of the sensor hubs, they are wearable for patients.

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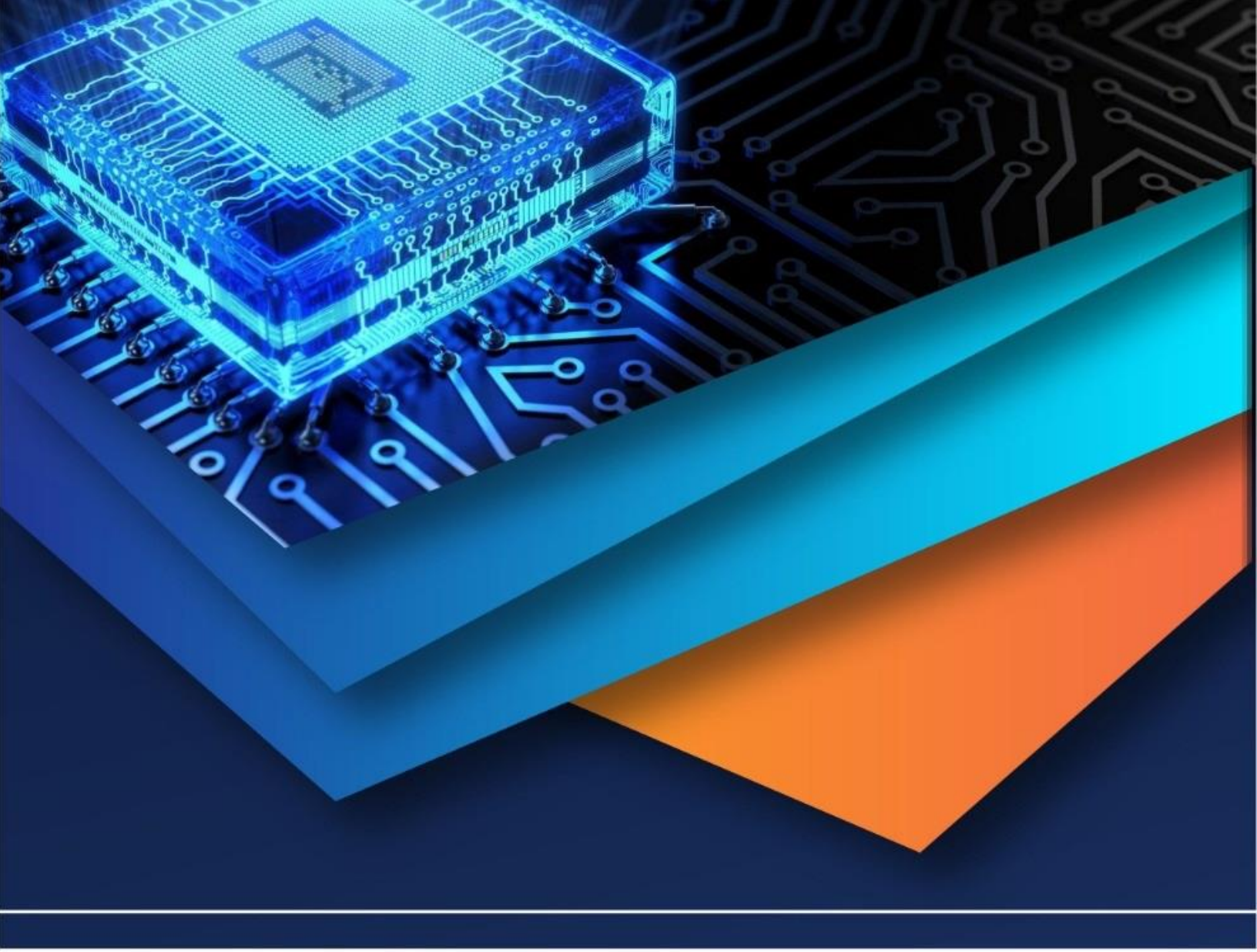

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