P- 3388

DETECTION OF ECG SIGNAL USING WAVELET TRANSFORM

By

V.ARUNADEVI **Reg. No. 0710107010**

B.BHAVANA **Reg. No. 0710107014**

S.DHIVYA KUMARI **Reg.No. 0710107022**

B.KEERTHANA **Reg.No. 0710107046**

Of

KUMARAGURU COLLEGE OF TECHNOLOGY

(An Autonomous Institution affiliated to Anna University, Coimbatore)

COIMBATORE - 641049

A PROJECT REPORT

Submitted to the

FACULTY OF ELECTRONICS AND COMMUNICATION ENGINEERING

In partial fulfillment of the requirements

For the award of the degree

Of

BACHELOR OF ENGINEERING

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

APRIL 2011

BONAFIDE CERTIFICATE

Certified that this project report entitled " **DETECTION OF ECG SIGNAL USING WAVELET TRANSFORM"** is the bonafide work of **Ms.V.ARUNADEVI** [Reg. no. 0710107010], **Ms.B.BHAVANA** [Reg. No. 0710107014], **Ms.S.DHIVYA KUMARI** [Reg. no. 0710107022], **Ms.B.KEERTHANA** [Reg. no. 0710107046] who carried out the research under my supervision. Certified further, that to the best of my knowledge the work reported herein does not form part of any other project or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

S.N. 16/4
Project Guide
Asst. Prof. S.N Shivappriya

Head of the Department
Dr.Rajeswari Mariappan

The candidates with university Register nos. 0710107010, 0710107014, 0710107022, 0710107046 is examined by us in the project viva-voce examination held on ...18.4.2011..

INTERNAL EXAMINAR 19/4

EXTERNAL EXAMINAR

ACKNOWLEDGEMENT

A project of this nature needs co-operation and support from many for successful completion. In this regards, I would like to express my thanks and appreciation to the many people who have contributed to the successful completion of this project.

I express my profound gratitude to our beloved Director **Dr.J.Shanmugam,** Kumaraguru College of Technology for his kind support and necessary facilities to carry out the work.

I would like to thank **Prof.Dr.S.Ramachandran Ph.D ,** Principal for providing us an opportunity to carry out this project work.

I express my gratitude to **Dr.Rajeswari Mariappan Ph.D,** Head of the Department, Electronics and Communication Engineering, who gave her continual support for me throughout the course of this project.

My heartfelt thanks to **Mrs.V.Jeyasri Arokiamary M.E,** Associate Professor and Project Coordinator, for her contribution and innovative ideas at various stages of the project and for her help to successful completion of this project work.

I express my gratitude to **Mrs S.N Shivappriya M.E,** Assistant Professor and my internal project guide, for her valuable guidance, innovative ideas and constant encouragement throughout this project.

I express my sincere gratitude to my family members, friends and to all my staff members of Electronics and Communication Engineering department for their support throughout the course of my project.

Last but not the least I would like to thank the God almighty without whose grace nothing would have been possible so far.

ABSTRACT

Automation in ECG signal processing is in high demand due to recent trends in clinical and telemedical applications. A new wavelet based framework is developed and evaluated for automatic analysis of ECG. The proposed system utilizes a robust pre-processing stage that enables it to handle noise. Wavelet transforms and filters are used to increase the signal to noise ratio of the signal, then employ efficient wavelet based beat detection mechanism to extract precise fiducial ECG points – QRS complex, P wave detection , T wave detection and R interval. Based on that detection of interval time 6 diseases are diagnosed.

1. INTRODUCTION

1. INTRODUCTION

1.1 ELECTROCARDIOGRAPHY

Electrocardiograph (ECG) is a transthoracic interpretation of the electrical activity of the heart over time captured and externally recorded by skin electrodes. It is a noninvasive recording produced by an electrocardiographic device.The ECG works mostly by detecting and amplifying the tiny electrical changes on the skin that are caused when the heart muscle "depolarizes" during each heart beat. At rest, each heart muscle cell has a charge across its outer wall, or cell membrane. Reducing this charge towards zero is called de-polarization, which activates the mechanisms in the cell that cause it to contract. During each heartbeat a healthy heart will have an orderly progression of a wave of depolarisation that is triggered by the cells in the sinoatrial node, spreads out through the atrium, passes through "intrinsic conduction pathways" and then spreads all over the ventricles. This is detected as tiny rises and falls in the voltage between two electrodes placed either side of the heart which is displayed as a wavy line either on a screen or on paper. This display indicates the overall rhythm of the heart and weaknesses in different parts of the heart muscle.

Usually more than 2 electrodes are used and they can be combined into a number of pairs (For example: Left arm (LA), right arm (RA) and left leg (LL) electrodes form the pairs: LA+RA, LA+LL, RA+LL). The output from each pair is known as a lead. Each lead is said to look at the heart from a different angle. Different types of ECGs can be referred to by the number of leads that are recorded, for example 3-lead, 5-lead or 12-lead ECGs (sometimes simply "a 12-lead"). A 12-lead ECG is one in which 12 different electrical signals are recorded at approximately the same time and

will often be used as a one-off recording of an ECG, typically printed out as a paper copy. 3- and 5-lead ECGs tend to be monitored continuously and viewed only on the screen of an appropriate monitoring device, for example during an operation or whilst being transported in an ambulance. There may, or may not be any permanent record of a 3- or 5-lead ECG depending on the equipment used.

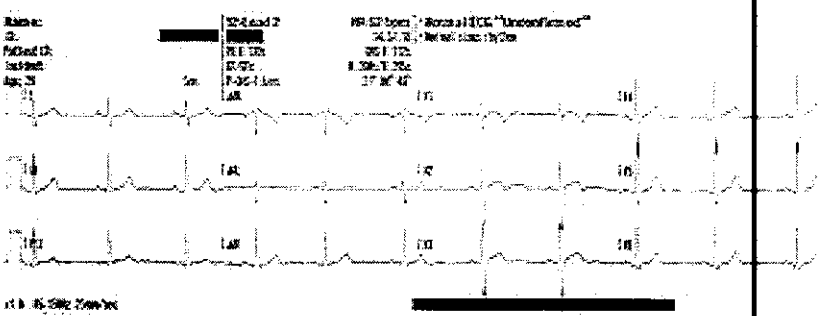


Fig 1.1 ECG pattern of 26 year old male

It is the best way to measure and diagnose abnormal rhythms of the heart particularly abnormal rhythms caused by damage to the conductive tissue that carries electrical signals, or abnormal rhythms caused by electrolyte imbalances. In a myocardial infarction (MI), the ECG can identify if the heart muscle has been damaged in specific areas, though not all areas of the heart are covered. The ECG cannot reliably measure the pumping ability of the heart, for which ultrasound-based (echocardiography) or nuclear medicine tests are used. It is possible to be in cardiac arrest with a normal ECG signal (a condition known as pulseless electrical activity).

1.2 LEADS

The term "lead" in electrocardiography causes much confusion because it is used to refer to two different things. In accordance with common parlance the word

lead may be used to refer to the electrical cable attaching the electrodes to the ECG recorder. As such it may be acceptable to refer to the "left arm lead" as the electrode (and its cable) that should be attached at or near the left arm. There are usually ten of these electrodes in a standard "12-lead" ECG.

Alternatively (and some would say properly, in the context of electrocardiography) the word lead may refer to the tracing of the voltage difference between two of the electrodes and is what is actually produced by the ECG recorder. Each will have a specific name. For example "Lead I" (lead one) is the voltage between the right arm electrode and the left arm electrode, whereas "Lead II" (lead two) is the voltage between the right limb and the feet. (This rapidly becomes more complex as one of the "electrodes" may in fact be a composite of the electrical signal from a combination of the other electrodes . Twelve of this type of lead form a "12-lead" ECG

To cause additional confusion the term "limb leads" usually refers to the tracings from leads I, II and III rather than the electrodes attached to the limbs.

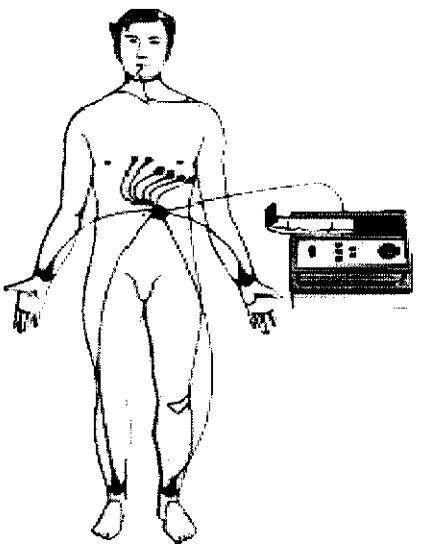


Fig.1.2 12-lead ECG

1.3 PLACEMENT OF ELECTRODES

Ten electrodes are used for a 12-lead ECG. The electrodes usually consist of a conducting gel, embedded in the middle of a self-adhesive pad onto which cables clip. Sometimes the gel also forms the adhesive. They are labeled and placed on the patient's body as follows:

Table 1 Placement of Leads

Electrode label (in the USA)	**Electrode placement**
RA	On the right arm, avoiding thick muscle.
LA	In the same location that RA was placed, but on the left arm this time.
RL	On the right leg, lateral calf muscle
LL	In the same location that RL was placed, but on the left leg this time.
V_1	In the *fourth* intercostal space (between ribs 4 & 5) just to the *right* of the sternum (breastbone).
V_2	In the *fourth* intercostal space (between ribs 4 & 5) just to the *left* of the sternum.
V_3	Between leads V_2 and V_4.
V_4	In the fifth intercostal space (between ribs 5 & 6) in the mid-clavicular line (the imaginary line that extends down from the midpoint of the clavicle (collarbone)).

V_5	Horizontally even with V_4, but in the anterior axillary line. (The anterior axillary line is the imaginary line that runs down from the point midway between the middle of the clavicle and the lateral end of the clavicle; the lateral end of the collarbone is the end closer to the arm.)
V_6	Horizontally even with V_4 and V_5 in the midaxillary line. (The midaxillary line is the imaginary line that extends down from the middle of the patient's armpit.)

1.4 WAVES AND INTERVALS

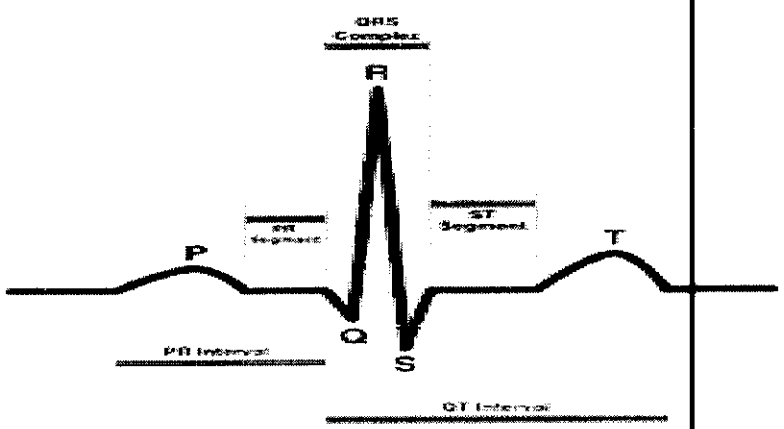


Fig1.4 Schematic representation of ECG

A typical ECG tracing of the cardiac cycle (heartbeat) consists of a P wave, a QRS complex, a T wave, and a U wave which is normally visible in 50 to 75% of ECGs The baseline voltage of the electrocardiogram is known as the isoelectric line. Typically the isoelcctric line is measured as the portion of the tracing following the T wave and preceding the next P wave.

Feature	Description	Duration
RR interval	The interval between an R wave and the next R wave . Normal resting heart rate is between 60 and 100 bpm	0.6 to 1.2s
P wave	During normal atrial depolarization, the main electrical vector is directed from the SA node towards the AV node, and spreads from the right atrium to the left atrium. This turns into the P wave on the ECG.	80ms
PR interval	The PR interval is measured from the beginning of the P wave to the beginning of the QRS complex. The PR interval reflects the time the electrical impulse takes to travel from the sinus node through the AV node and entering the ventricles. The PR interval is therefore a good estimate of AV node function.	120 to 200ms
PR segment	The PR segment connects the P wave and the QRS complex. This coincides with the electrical conduction from the AV node to the bundle of His to the bundle branches and then to the Purkinje Fibers. This electrical activity does not produce a contraction directly and is merely traveling down towards the ventricles and this shows up flat on the ECG. The PR interval is more clinically relevant.	50 to 120ms
QRS complex	The QRS complex reflects the rapid depolarization of the right and left ventricles. They have a large muscle mass compared to the atria and so the QRS complex usually has a much larger amplitude than the P-wave.	80 to 120ms
J-point	The point at which the QRS complex finishes and the ST segment begins. Used to measure the degree of ST elevation or depression present.	N/A
ST segment	The ST segment connects the QRS complex and the T wave. The ST segment represents the period when the ventricles are depolarized. It is isoelectric.	80 to 120ms
T wave	The T wave represents the repolarization (or recovery) of the ventricles. The	160ms

	interval from the beginning of the QRS complex to the apex of the T wave is referred to as the absolute refractory period. The last half of the T wave is referred to as the relative refractory period (or vulnerable period).	
ST interval	The ST interval is measured from the J point to the end of the T wave.	320ms
QT interval	The QT interval is measured from the beginning of the QRS complex to the end of the T wave. A prolonged QT interval is a risk factor for ventricular tachyarrhythmias and sudden death. It varies with heart rate and for clinical relevance requires a correction for this, giving the QTc.	300 to 430ms

Table 2 Details of PQRST wave and intervals

There were originally four deflections, but after the mathematical correction for artifacts introduced by early amplifiers, five deflections were discovered. Einthoven chose the letters P, Q, R, S, and T to identify the tracing which was superimposed over the uncorrected labeled A, B, C, and D.

In intracardiac electrocardiograms, such as can be acquired from pacemaker sensors, an additional wave that can be seen is the H deflection, which reflects the depolarization of the bundle of His. The H-V interval, in turn, is the duration from the beginning of the H deflection to the earliest onset of ventricular depolarization recorded in any lead.

1.5 DISEASES

Conditions due to which the diseases occur:

Bradycardia	RR interval>1s	
Tachycardia	RR interval<0.6s	
Hypercalcaemia	QRS complex<0.1s	
Hyperkalemia	Absence of P wave	
Dextrocardia	Inverted P wave	
Myocardial ischaemia	Inverted T wave	

1.5.1 BRADYCARDIA

Bradycardia (bradykardía, "heart slowness"), in the context of adult medicine, is the resting heart rate of under 60 beats per minute, though it is seldom symptomatic until the rate drops below 50 beat/min. It may cause cardiac arrest in some patients, because those with bradycardia may not be pumping enough oxygen to their heart. It sometimes results in fainting, shortness of breath, and if severe enough, death.

Trained athletes or young healthy individuals may also have a slow resting heart rate (e.g. professional cyclist Miguel Indurain had a resting heart rate of 28

beats per minute). Resting bradycardia is often considered normal if the individual has no other symptoms such as fatigue, weakness, dizziness, lightheadedness, fainting, chest discomfort, palpitations or shortness of breath associated with it.

The term relative bradycardia is used in explaining a heart rate which although not actually below 60 beats per minute still is considered too slow for the individual's current medical condition.

1.5.2 DEXTROCARDIA

Dextrocardia is a congenital defect in which the heart is situated on the right side of the body. There are two main types of dextrocardia,dextrocardia of embryonic arrest (also known as isolated dextrocardia) and dextrocardia situs inversus. Dextrocardia situs inversus is further divided.

1.5.3 HYPERCALCAEMIA

Hypercalcaemia (in American English, hypercalcemia) is an elevated calcium level in the blood. (Normal range: 9–10.5 mg/dL or 2.2–2.6 mmol/L). It can be an asymptomatic laboratory finding, but because an elevated calcium level is often indicative of other diseases, a diagnosis should be undertaken if it persists. It can be due to excessive skeletal calcium release, increased intestinal calcium absorption, or decreased renal calcium excretion.

1.5.4 MYOCARDIAL ISCHEMIA

Myocardial ischemia (also known as angina) is a heart condition caused by a temporary lack of oxygen-rich blood to the heart. There are three types, each of which is signified by pain. The stable type occurs when the heart is working harder than

usual and generally goes away with rest; unstable myocardial ischemia is dangerous and requires emergency treatment; variant (also called Prinzmetal's angina) occurs at rest and can be relieved by medicine.

More than 6 million Americans live with myocardial ischemia, or **angina**. The term refers to chest pain or discomfort that occurs when the heart muscle is not getting enough oxygen-rich blood for a short period of time. The inadequate blood flow is caused by narrowed coronary arteries, which are the vessels that supply blood to the heart. A bout of myocardial ischemia is not a **heart attack**, but it means that you're more likely to have a heart attack than someone who doesn't have myocardial ischemia.

1.5.5 HYPERKALEMIA

Hyperkalemia (hyperkalaemia in British English, hyper- high; kalium, potassium; -emia, "in the blood") refers to the condition in which the concentration of the electrolyte potassium (K^+) in the blood is elevated. Extreme hyperkalemia is a medical emergency due to the risk of potentially fatal abnormal heart rhythms (arrhythmia). The prefix hyper- means high(contrast with hypo-, meaning low). Kal refers to kalium, the Neo-Latin for potassium, and -emia means "in the blood. Normal serum potassium levels are between 3.5 and 5.0 mEq/L; at least 95% of the body's potassium is found inside cells, with the remainder in the blood. This concentration gradient is maintained principally by the Na+/K+ pump.

2. ANALYSIS OF ECG SIGNAL

2. ANALYSIS OF ECG SIGNAL

2.1 SIGNAL FETCHING

The signal samples are downloaded from MIT BIH database and European database. Each signal sample consists of data file, header file and attributes file. This standard format is converted to MATLAB format. First the header file is loaded. Then the binary data is loaded and then the attributes are loaded. Thus the signals are fetched and then the pre-processing is done.

2.2 PREPROCESSING OF ECG

2.2.1 ARTIFACTS IN ECG SIGNAL

ECG contaminants can be classified into the following categories:

- power line interference
- electrode pop or contact noise
- patient–electrode motion artifacts
- electromyographic (EMG) noise
- baseline wandering

2.2.2 FILTERING OF SIGNAL

Presence of these artifacts affects the analysis. Hence it is necessary to remove these artifacts from the signal to achieve efficiency.The signal is first filtered using low pass filter. The frequency is 250Hz. Then the signal is denoised using wavelet transform.

2.2.3 CONTINUOUS WAVELET TRANSFORM

In continuous wavelet transforms, a given signal of finite energy is projected on a continuous family of frequency bands (or similar subspaces of the L^p function space $L^2(\mathbb{R})$). For instance the signal may be represented on every frequency band of the form $[f,2f]$ for all positive frequencies $f>0$. Then, the original signal can be reconstructed by a suitable integration over all the resulting frequency components.

The frequency bands or subspaces (sub-bands) are scaled versions of a subspace at scale 1. This subspace in turn is in most situations generated by the shifts of one generating function $\psi \in L^2(\mathbb{R})$, the mother wavelet. For the example of the scale one frequency band [1,2] this function is

$$\psi(t) = 2\,\mathrm{sinc}(2t) - \mathrm{sinc}(t) = \frac{\sin(2\pi t) - \sin(\pi t)}{\pi t}$$

with the (normalized) sinc function.

The subspace of scale a or frequency band $[1/a,\ 2/a]$ is generated by the functions (sometimes called child wavelets)

$$\psi_{a,b}(t) = \frac{1}{\sqrt{a}}\psi\left(\frac{t-b}{a}\right),$$

where a is positive and defines the scale and b is any real number and defines the shift. The pair (a,b) defines a point in the right halfplane $\mathbb{R}_+ \times \mathbb{R}$.

The projection of a function x onto the subspace of scale a then has the form

$$x_a(t) = \int_{\mathbb{R}} WT_\psi\{x\}(a,b) \cdot \psi_{a,b}(t)\, db$$

with wavelet coefficients

$$WT_\psi\{x\}(a,b) = \langle x, \psi_{a,b}\rangle = \int_{\mathbb{R}} x(t)\overline{\psi_{a,b}(t)}\, dt$$

2.2.4 DENOISING OF SIGNAL

Continuous wavelet transform is used to denoise the ecg signal. In CWT, Debauchies mode is used. The scales used are 2^1, 2^2, 2^3, 2^4. The data after wavelet transform is analysed to determine the peaks and intervals.

2.3 QRS COMPLEX DETECTION

The QRS complex is the most characteristic waveform of the ECG signal. Onset and offset of the QRS complex have high frequency and low amplitude signal, which are detected at finer scales(2^1) rather than the original signal. This is to avoid the effect of baseline drift.

2.3.1 R PEAK DETECTION

In the ECG signal R-wave is having maximum amplitude, which has to be detected at scale (2^3) to find other peaks. In this project we have checked for any zero crossing. If a zero crossing has been found, the point is moved left. This is done for entire data and the peaks at various points are determined.

2.3.2 RR INTERVAL

RR interval is very essential to find the presence of arrhythmia. The time difference between the two R-peaks is determined. This is the RR interval.

2.3.3 R WAVE ABNORMALITIES

Several arrhythmias can be determined using the R peak and RR interval. If the RR interval is greater than 1second then the arrhythmia is Bradycardia. If the RR interval is less than 0.6 second, then the arrhythmia is Tachycardia.

2.3.4 Q PEAK

First the Qpeak is assigned as NaN. Then it is checked if the mean of the data in previous three locations is less than the data in the previous location. If it is satisfied then the largest slope is found. Then the present location is moved to left. Thus Q peak is found. Using Q peak, S peak is determined.

2.3.5 S PEAK

S peak is determined from the Q peak and R peak. It is checked if the mean of data in the next three locations is less than the data in the present location then the present location is shifted towards right. Thus S peak is determined.

2.3.6 QRS INTERVAL AND THE IRREGULARITY

QRS interval is the time period between the onset of Q wave and the offset of the S wave. QRS interval is used to determine several arrhythmias. One such arrhythmia is Hypercalcaemia. If the QRS interval is less than 0.1 second then the arrhythmia is Hypercalcaemia.

2.4 PT WAVE

2.4.1 P AND T PEAK

PT segment is first found. Wavelet transform is performed. The largest two peaks is determined. The maximum of two peaks is the P peak. The minimum of two peaks is taken as T peak. 2^1 scale is used to detect P and T peak.

2.4.2 PT ONSET AND OFFSET

If the data of location is greater than 0 and the location less than 1 then the previous location is taken as onset. Similarly if the data of the location is greater than 0 and location less than the length of data then the next location is considered as offset. The same algorithm is used to find the onset and offset of both P wave and T wave.

2.4.3 P WAVE IRREGULARITY

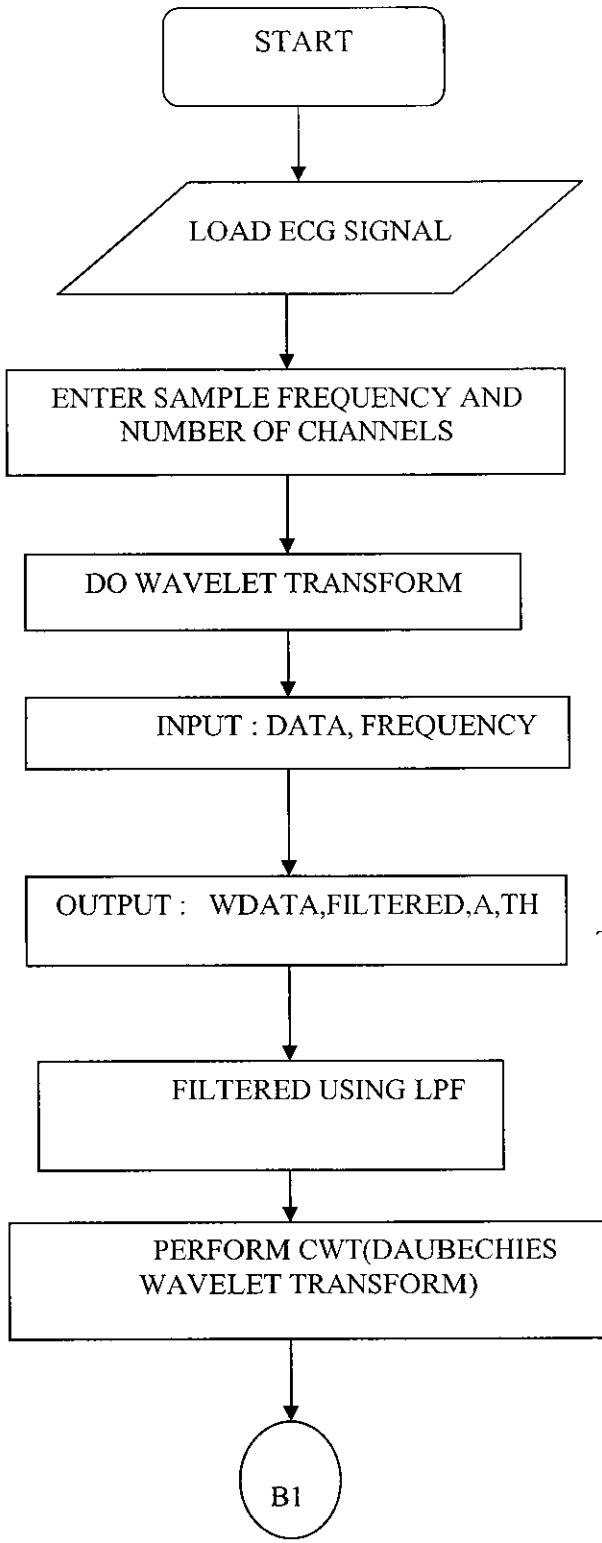
The presence of the P wave and the appearance of P wave is used to determine certain disorders. If the P wave is absent, then the disorder is Hyperkalemia. If the P wave is inverted then the disorder is Dextrocardia.

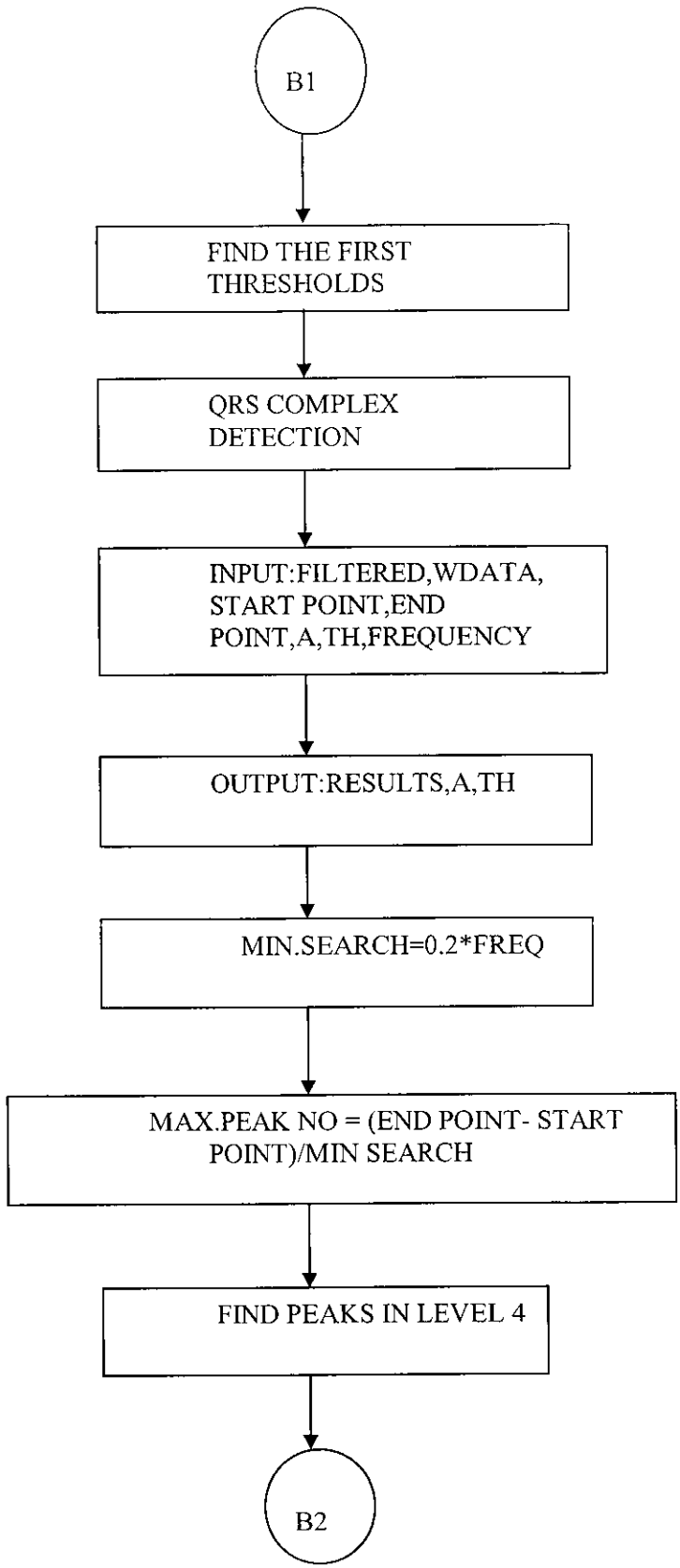
2.4.4 T WAVE IRREGULARITY

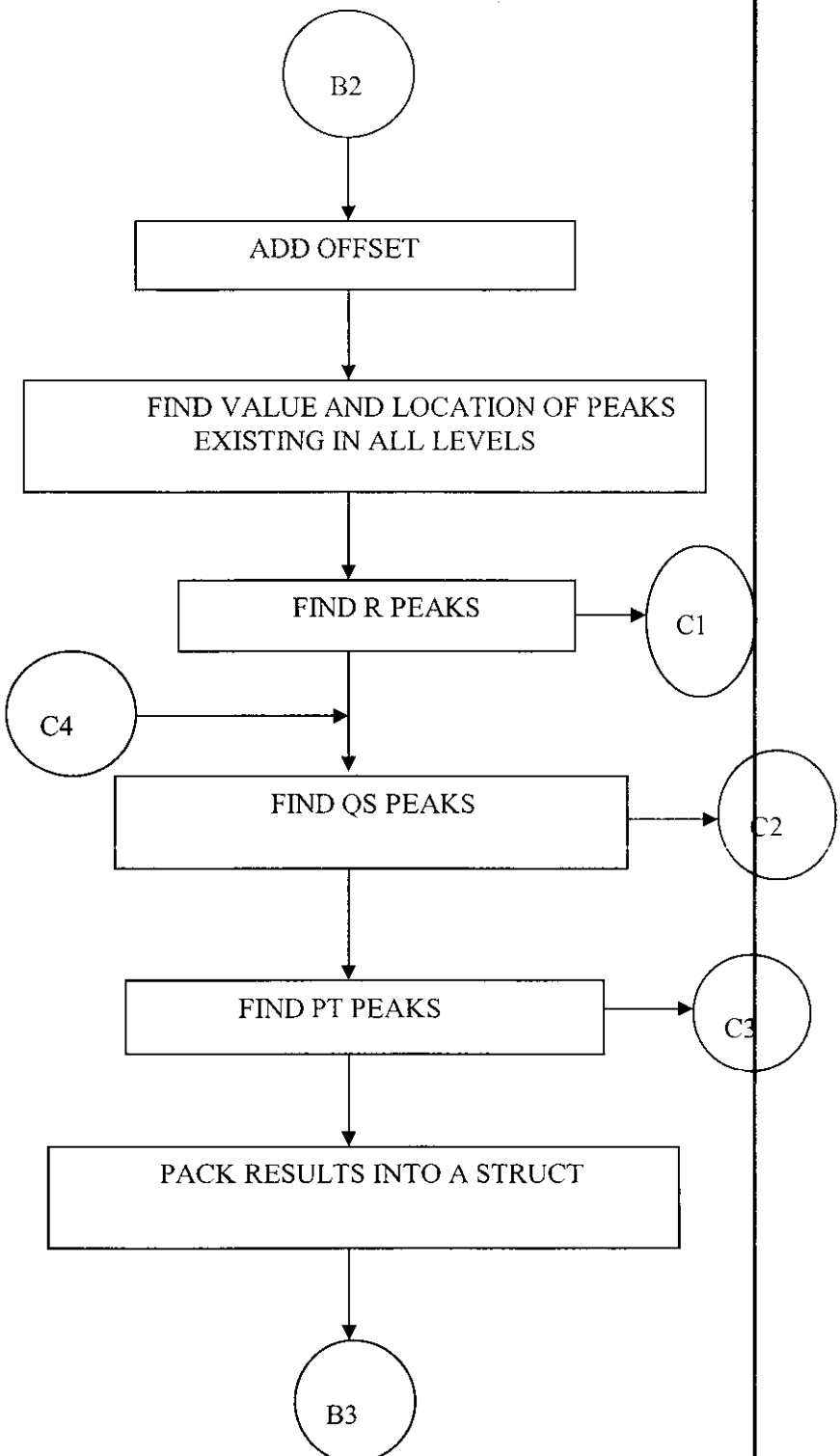
The appearance of T wave is used to detect Myocardial ischemia. If the T wave is inverted then it is inferred that Myocardial ischemia is present.

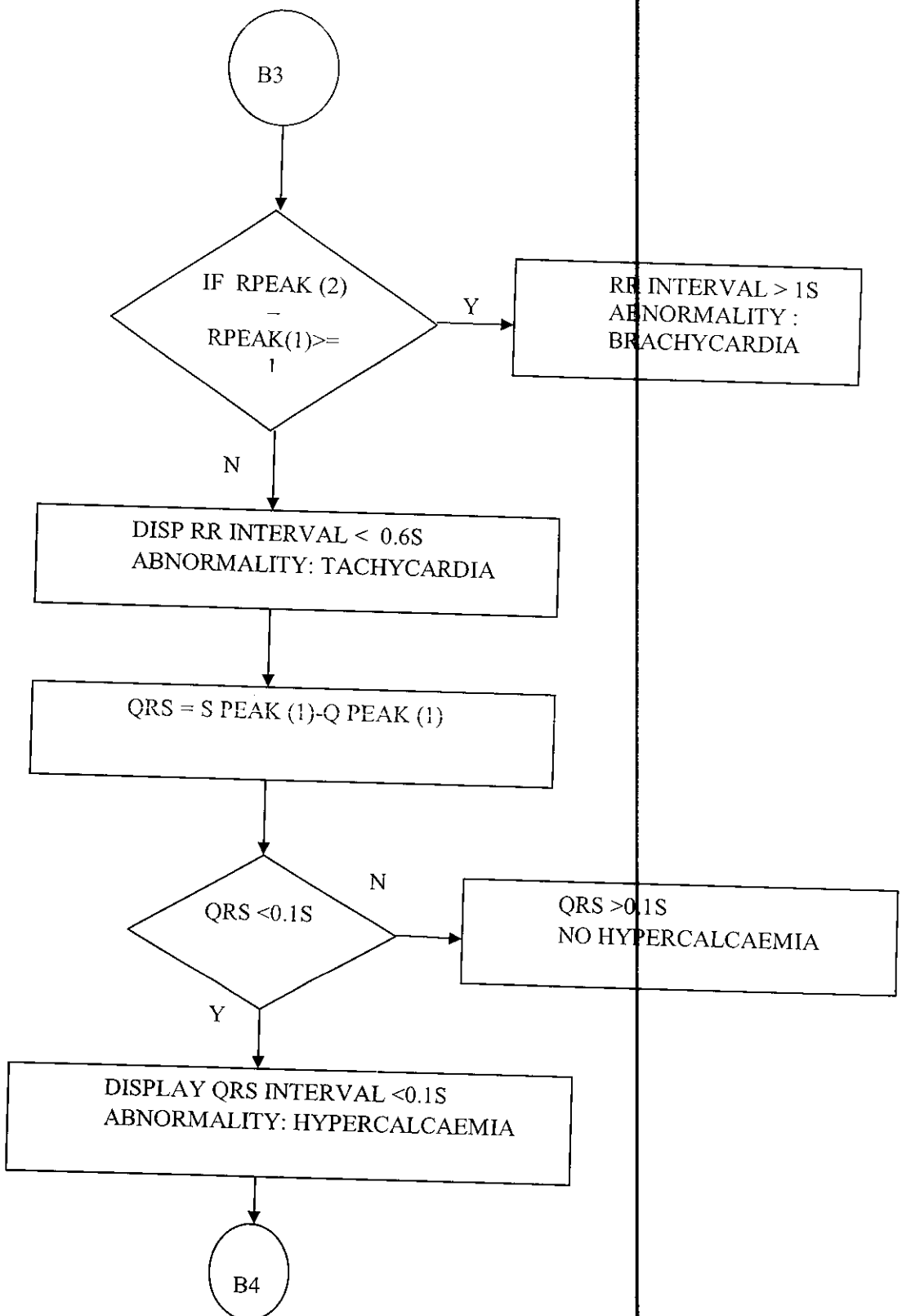
3. FLOWCHART

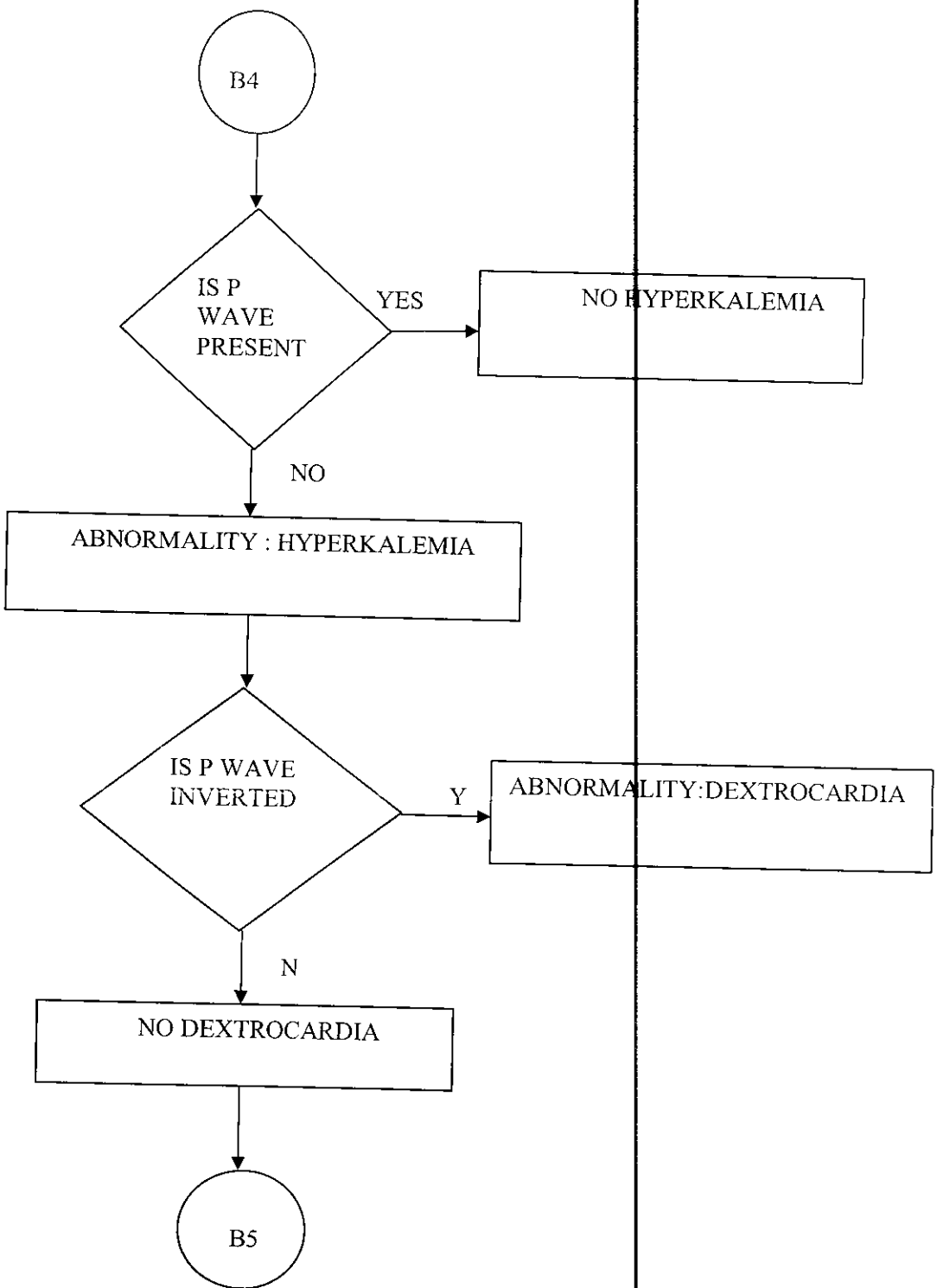
3. FLOWCHART

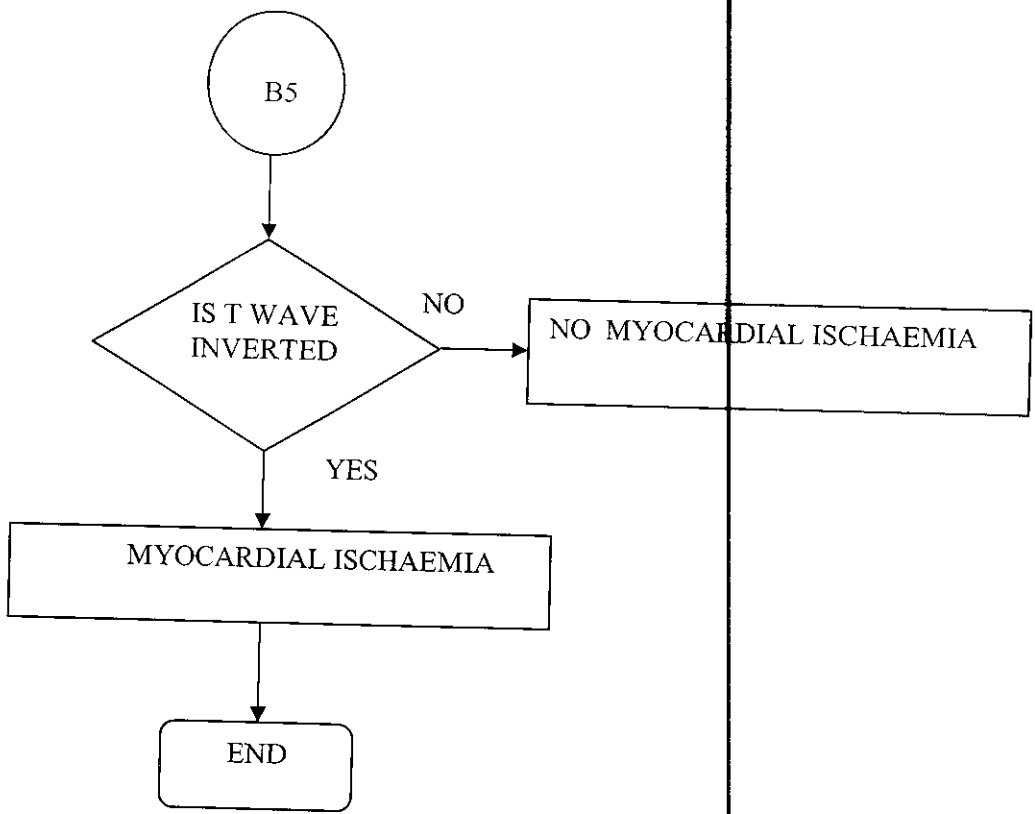

START
LOAD ECG SIGNAL
ENTER SAMPLE FREQUENCY AND NUMBER OF CHANNELS
DO WAVELET TRANSFORM
INPUT : DATA, FREQUENCY
OUTPUT : WDATA,FILTERED,A,TH
A – WINDOW SIZE
TH - THRESHOLD
FILTERED USING LPF
PERFORM CWT(DAUBECHIES WAVELET TRANSFORM)
B1

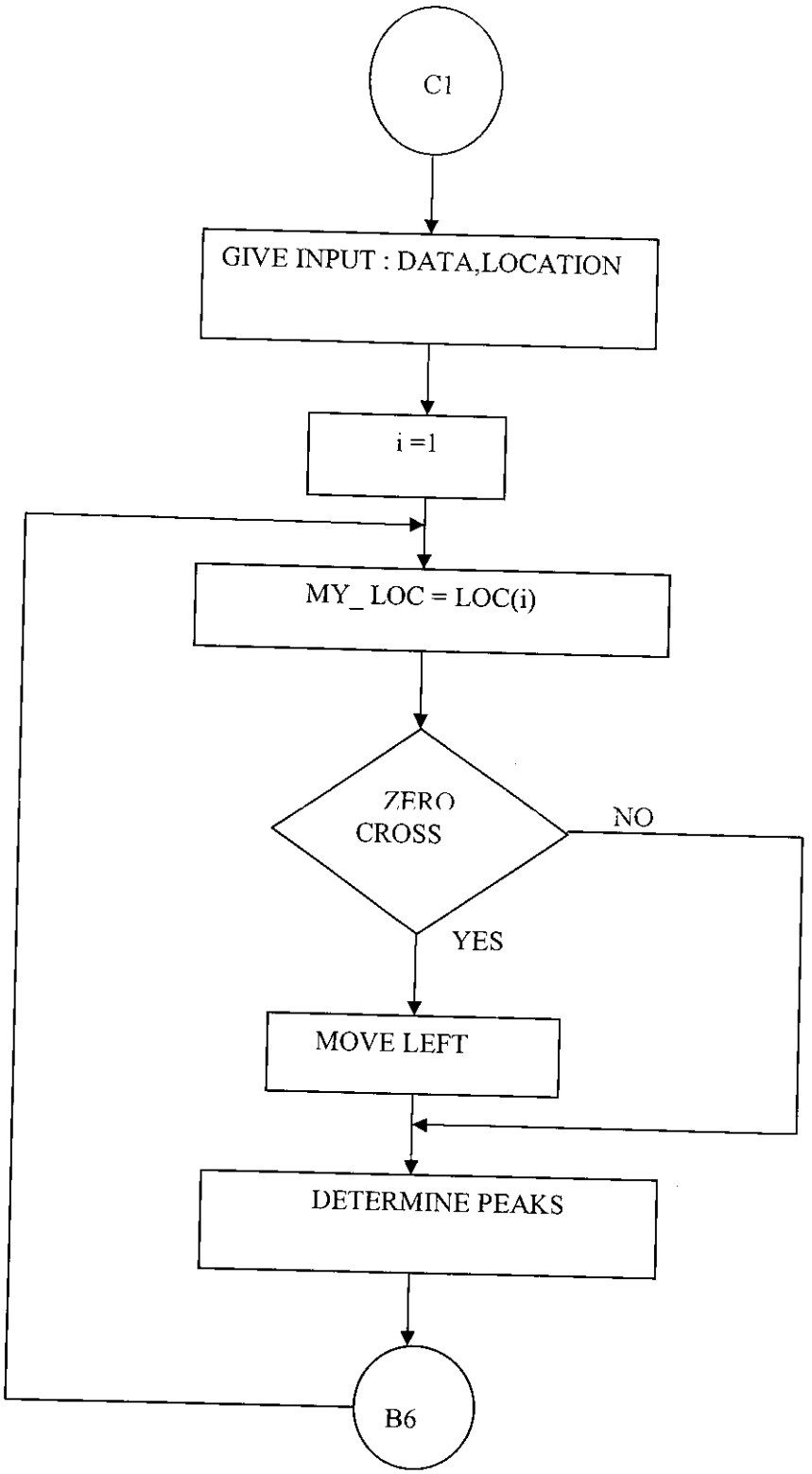

B1
FIND THE FIRST THRESHOLDS
QRS COMPLEX DETECTION
INPUT:FILTERED,WDATA, START POINT,END POINT,A,TH,FREQUENCY
OUTPUT:RESULTS,A,TH
MIN.SEARCH=0.2*FREQ
MAX.PEAK NO = (END POINT- START POINT)/MIN SEARCH
FIND PEAKS IN LEVEL 4
B2

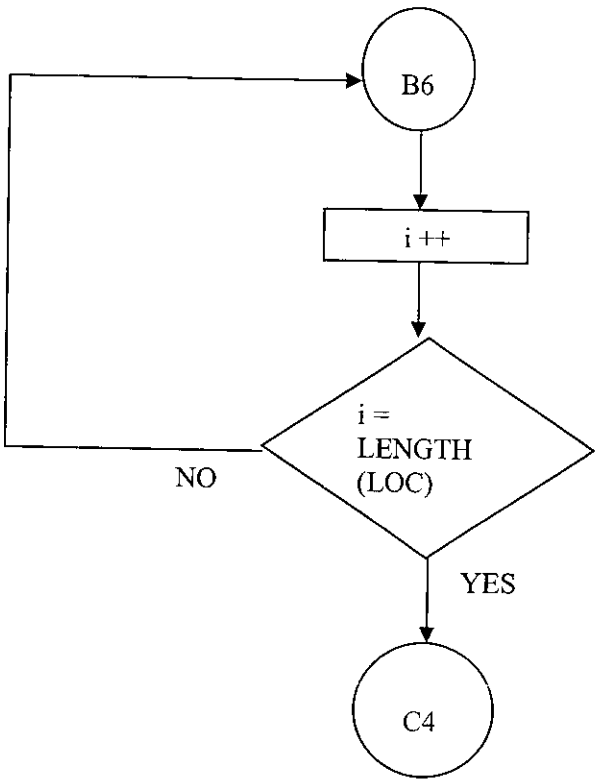

B2
ADD OFFSET
FIND VALUE AND LOCATION OF PEAKS EXISTING IN ALL LEVELS
FIND R PEAKS
C1
C4
FIND QS PEAKS
C2
FIND PT PEAKS
C3
PACK RESULTS INTO A STRUCT
B3

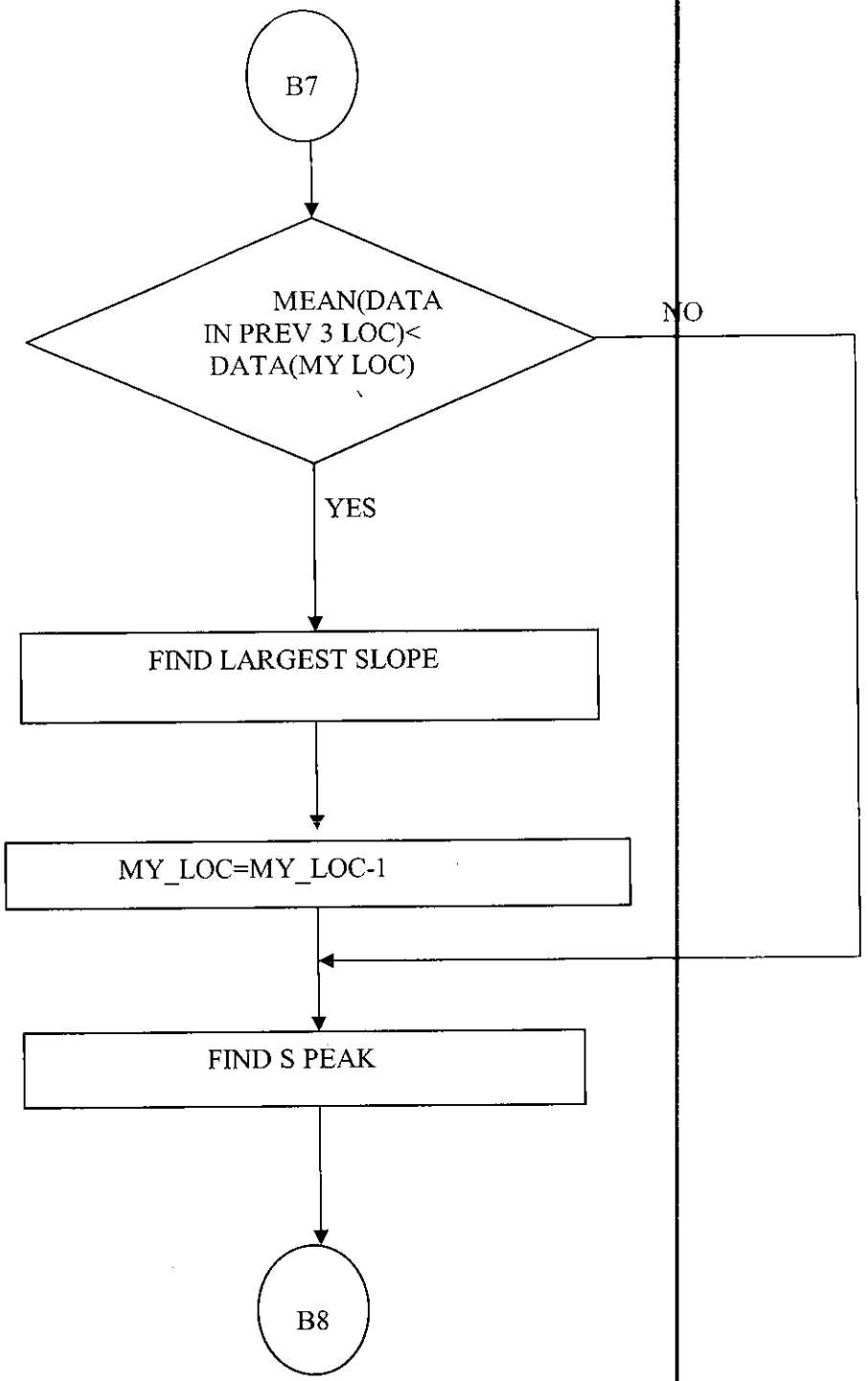

B3
IF RPEAK (2) – RPEAK(1)>= 1
Y
RR INTERVAL > 1S
ABNORMALITY : BRACHYCARDIA
N
DISP RR INTERVAL < 0.6S
ABNORMALITY: TACHYCARDIA
QRS = S PEAK (1)-Q PEAK (1)
QRS <0.1S
N
QRS >0.1S
NO HYPERCALCAEMIA
Y
DISPLAY QRS INTERVAL <0.1S
ABNORMALITY: HYPERCALCAEMIA
B4

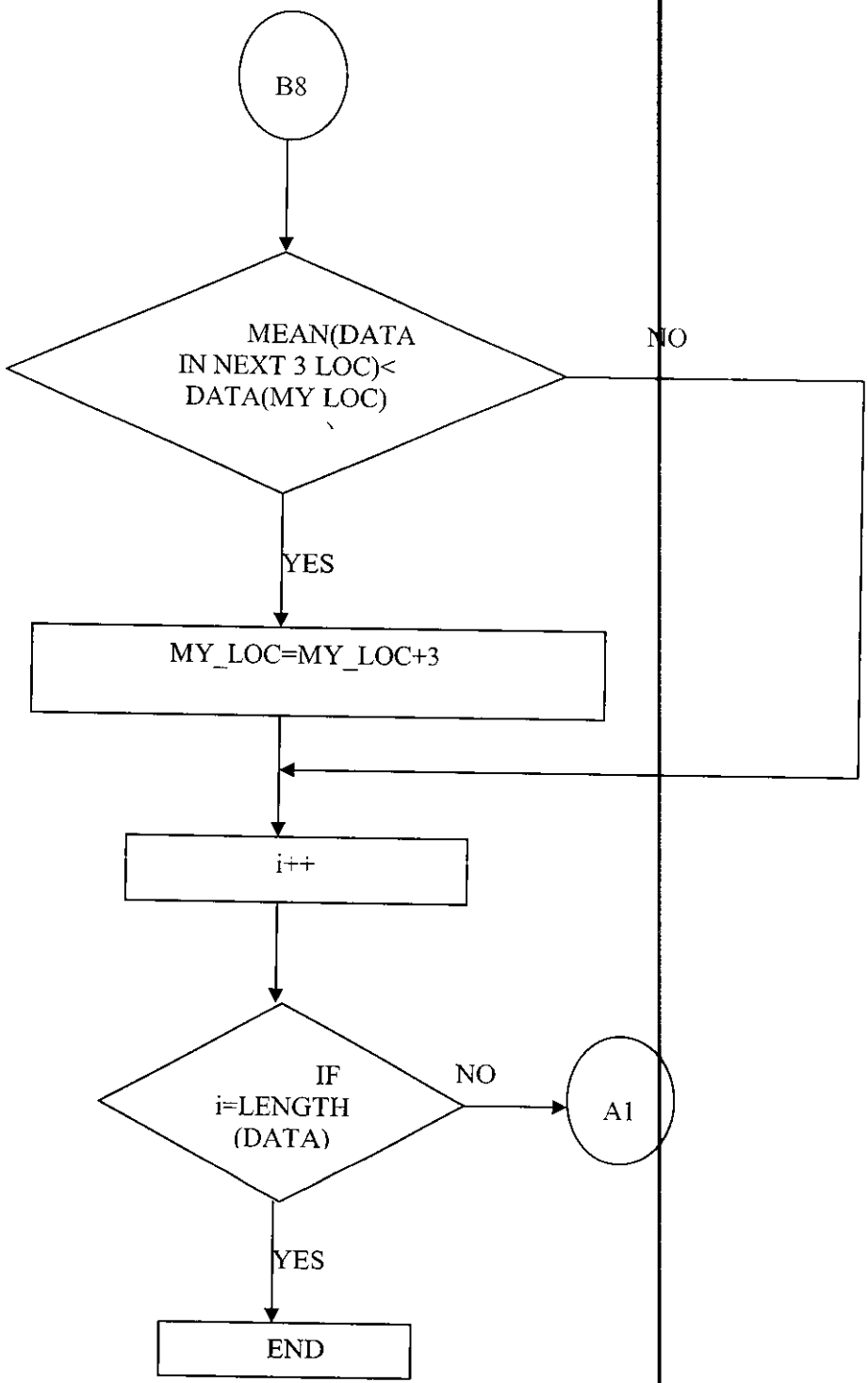

B4
IS P WAVE PRESENT
YES
NO HYPERKALEMIA
NO
ABNORMALITY : HYPERKALEMIA
IS P WAVE INVERTED
Y
ABNORMALITY:DEXTROCARDIA
N
NO DEXTROCARDIA
B5

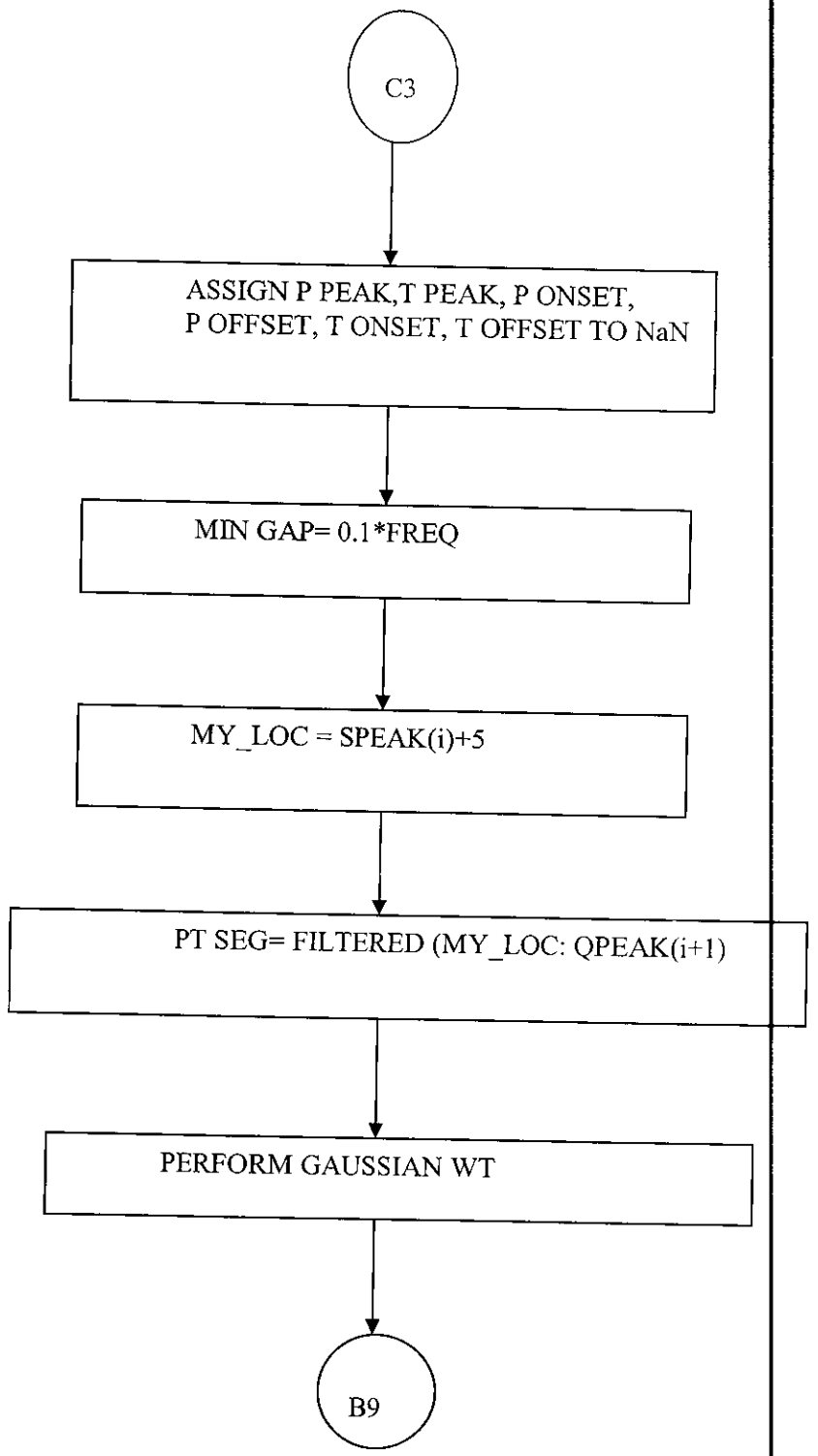

B5
IS T WAVE INVERTED
NO
NO MYOCARDIAL ISCHAEMIA
YES
MYOCARDIAL ISCHAEMIA
END

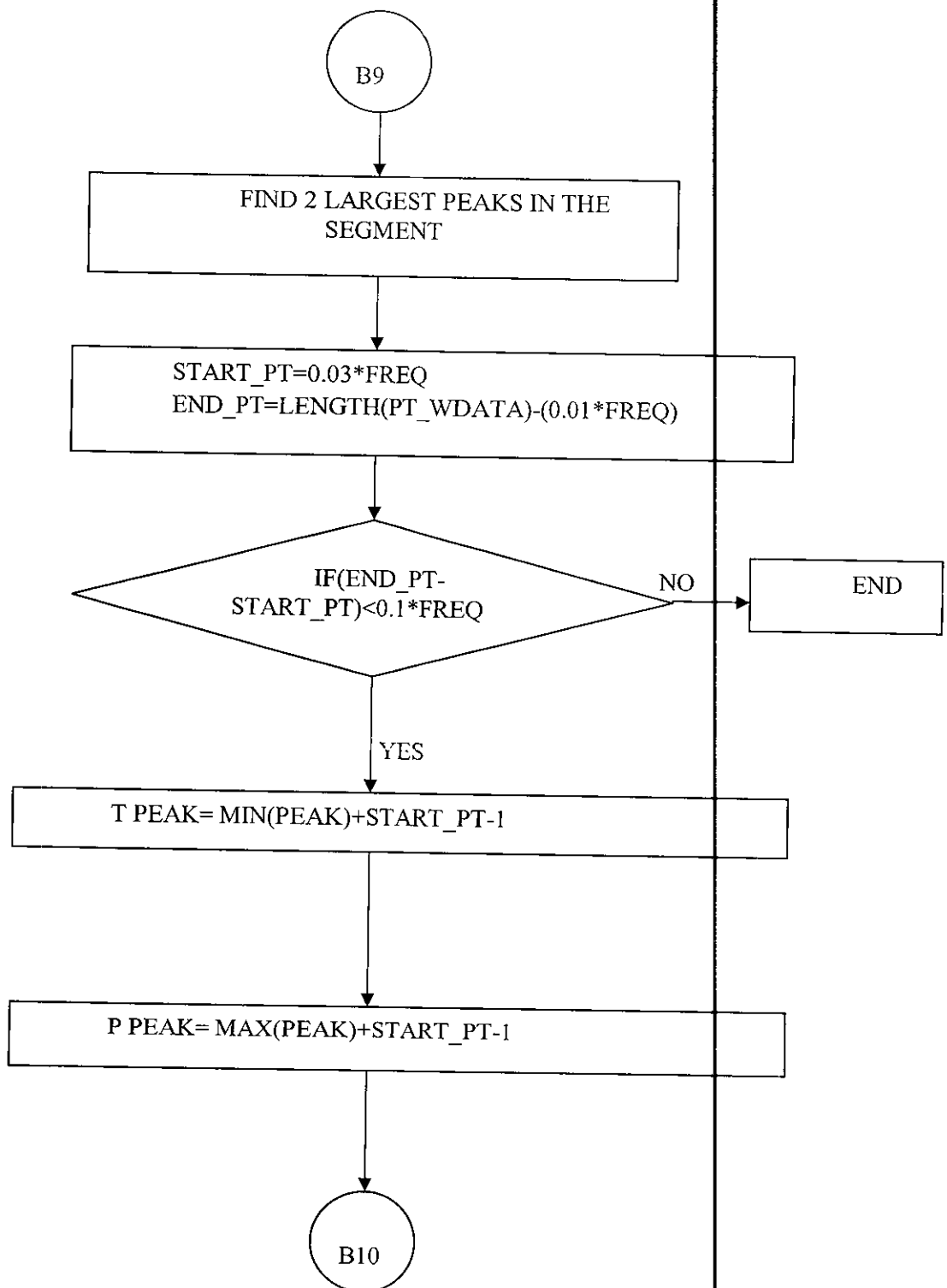

C1
GIVE INPUT : DATA,LOCATION
i =1
MY_ LOC = LOC(i)
ZERO CROSS
NO
YES
MOVE LEFT
DETERMINE PEAKS
B6

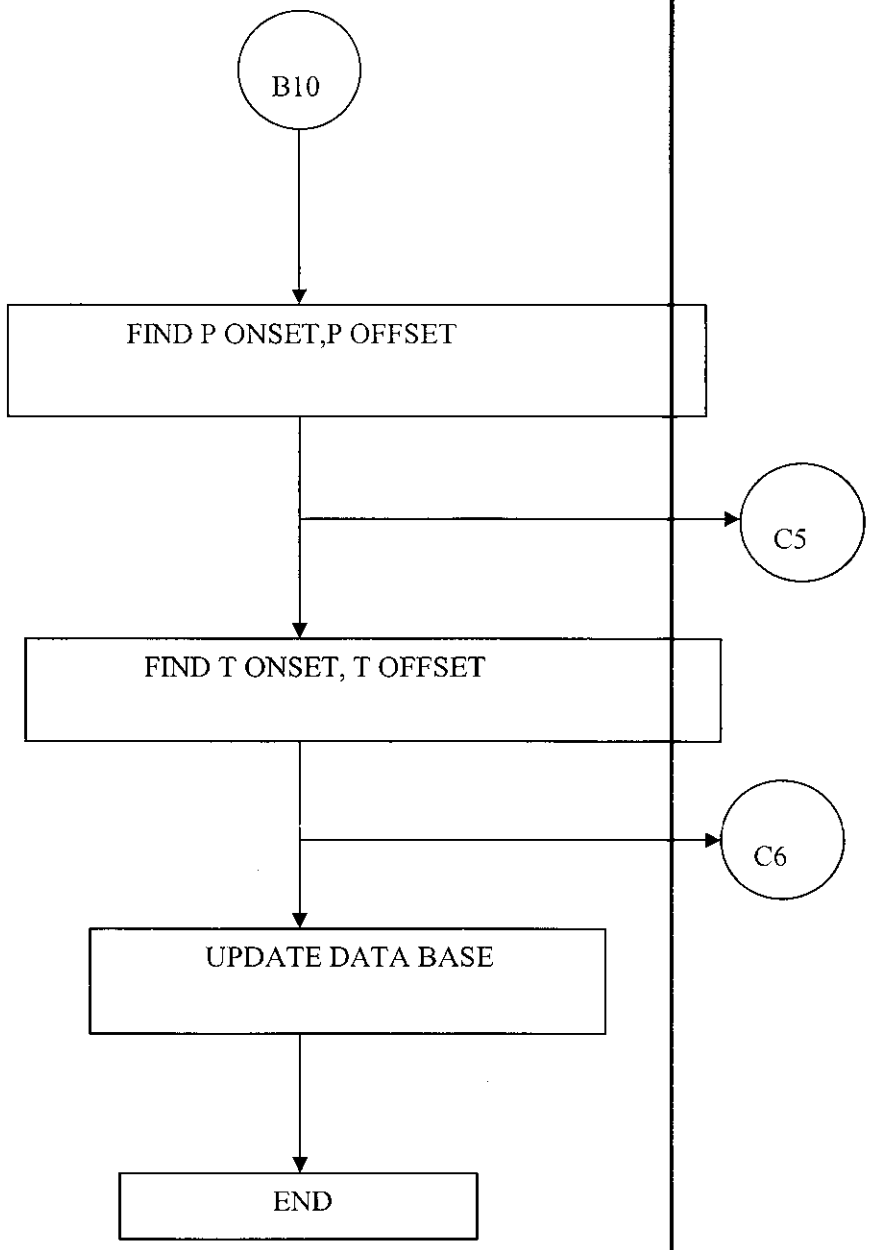

B6
i ++
i =
LENGTH
(LOC)
NO
YES
C4

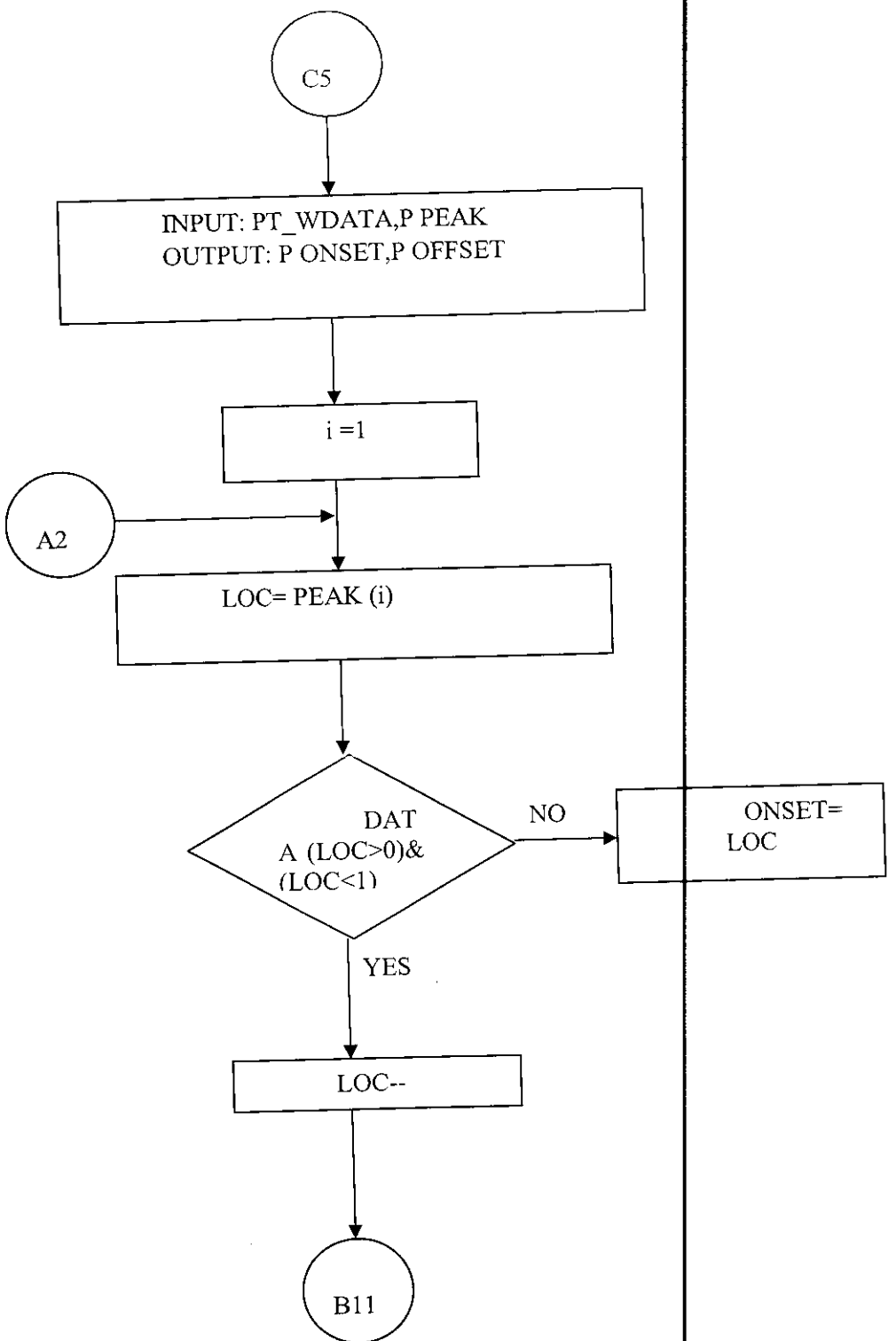

B7
MEAN(DATA IN PREV 3 LOC)< DATA(MY LOC)
NO
YES
FIND LARGEST SLOPE
MY_LOC=MY_LOC-1
FIND S PEAK
B8

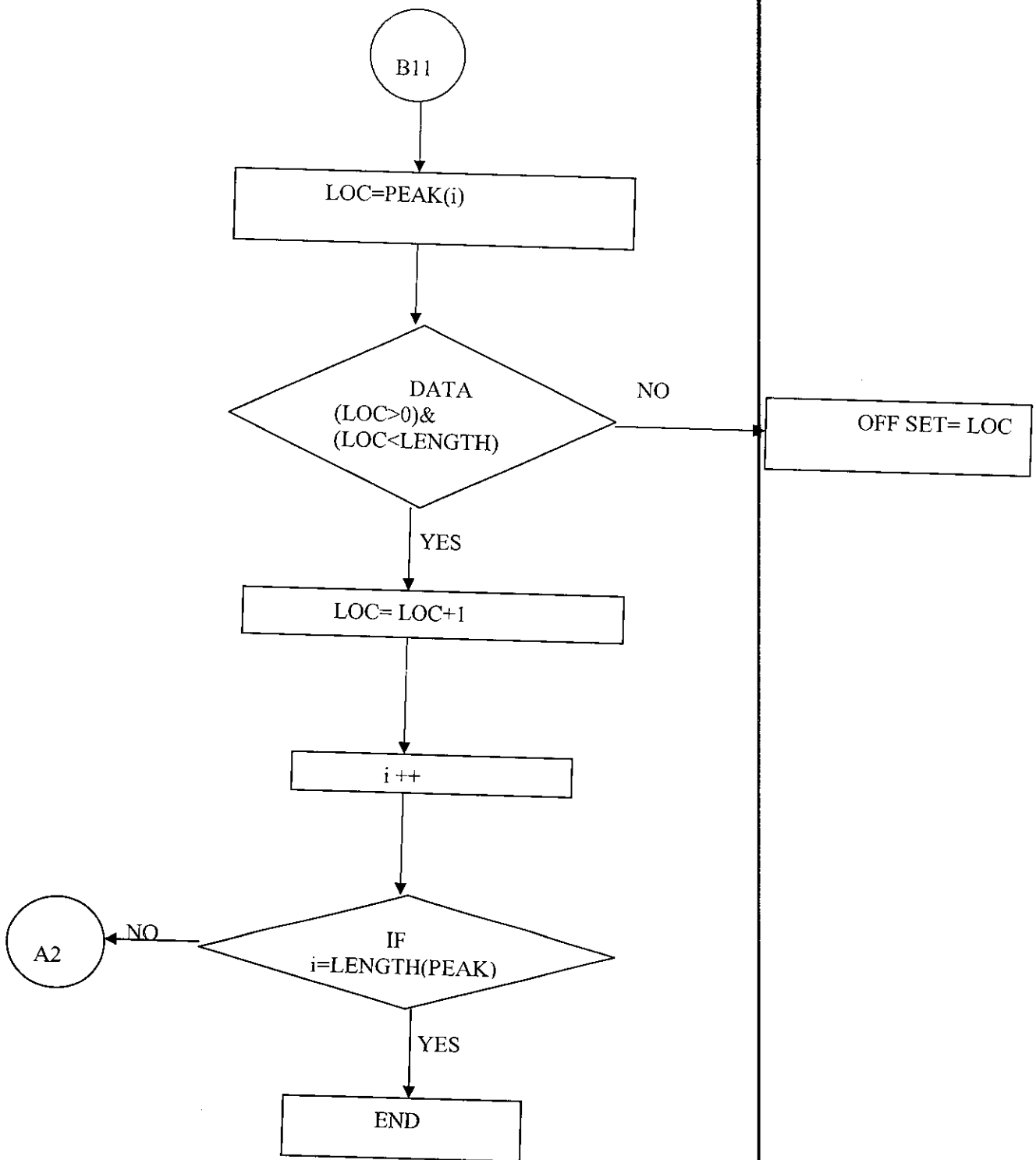

B8
MEAN(DATA IN NEXT 3 LOC)< DATA(MY LOC)
NO
YES
MY_LOC=MY_LOC+3
i++
IF i=LENGTH (DATA)
NO
A1
YES
END

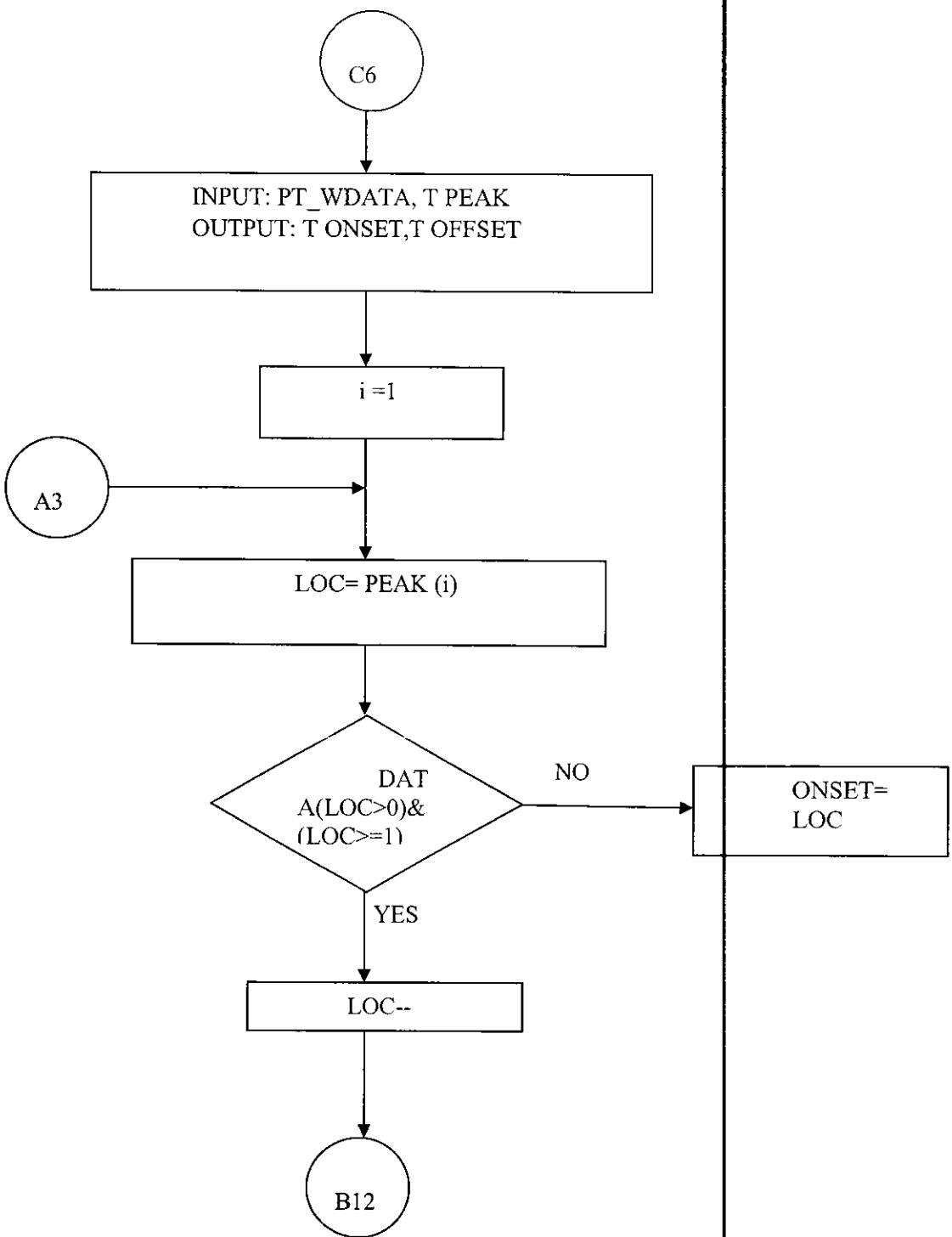

C3
ASSIGN P PEAK,T PEAK, P ONSET,
P OFFSET, T ONSET, T OFFSET TO NaN
MIN GAP= 0.1*FREQ
MY_LOC = SPEAK(i)+5
PT SEG= FILTERED (MY_LOC: QPEAK(i+1)
PERFORM GAUSSIAN WT
B9

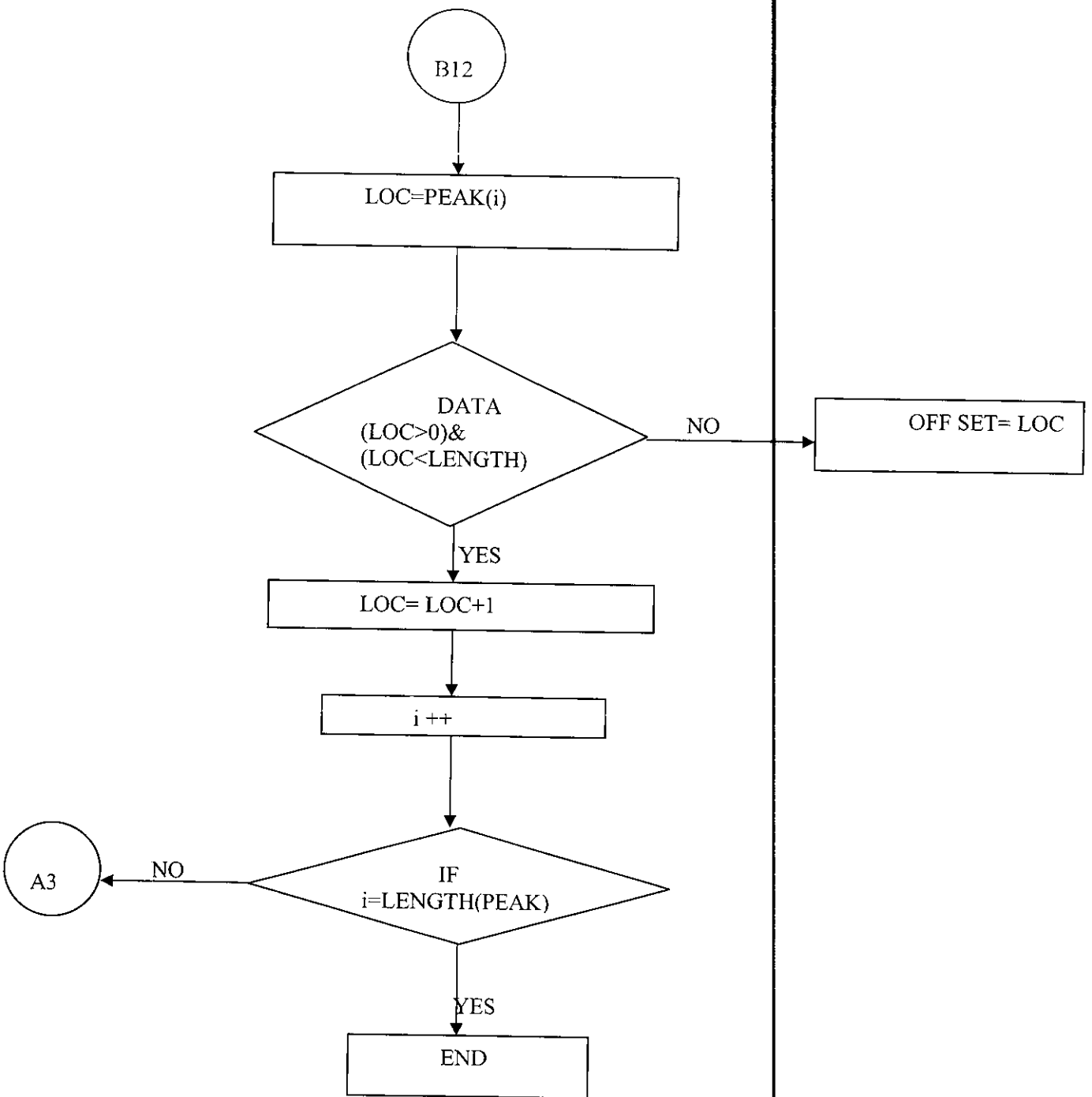

B9
FIND 2 LARGEST PEAKS IN THE SEGMENT
START_PT=0.03*FREQ
END_PT=LENGTH(PT_WDATA)-(0.01*FREQ)
IF(END_PT-START_PT)<0.1*FREQ
NO
END
YES
T PEAK= MIN(PEAK)+START_PT-1
P PEAK= MAX(PEAK)+START_PT-1
B10


B10
FIND P ONSET,P OFFSET
C5
FIND T ONSET, T OFFSET
C6
UPDATE DATA BASE
END


C5
INPUT: PT_WDATA,P PEAK
OUTPUT: P ONSET,P OFFSET
i =1
A2
LOC= PEAK (i)
DAT
A (LOC>0)&
(LOC<1)
NO
ONSET=
LOC
YES
LOC--
B11


B11
LOC=PEAK(i)
DATA
(LOC>0)&
(LOC<LENGTH)
NO
OFF SET= LOC
YES
LOC= LOC+1
i ++
A2
NO
IF
i=LENGTH(PEAK)
YES
END

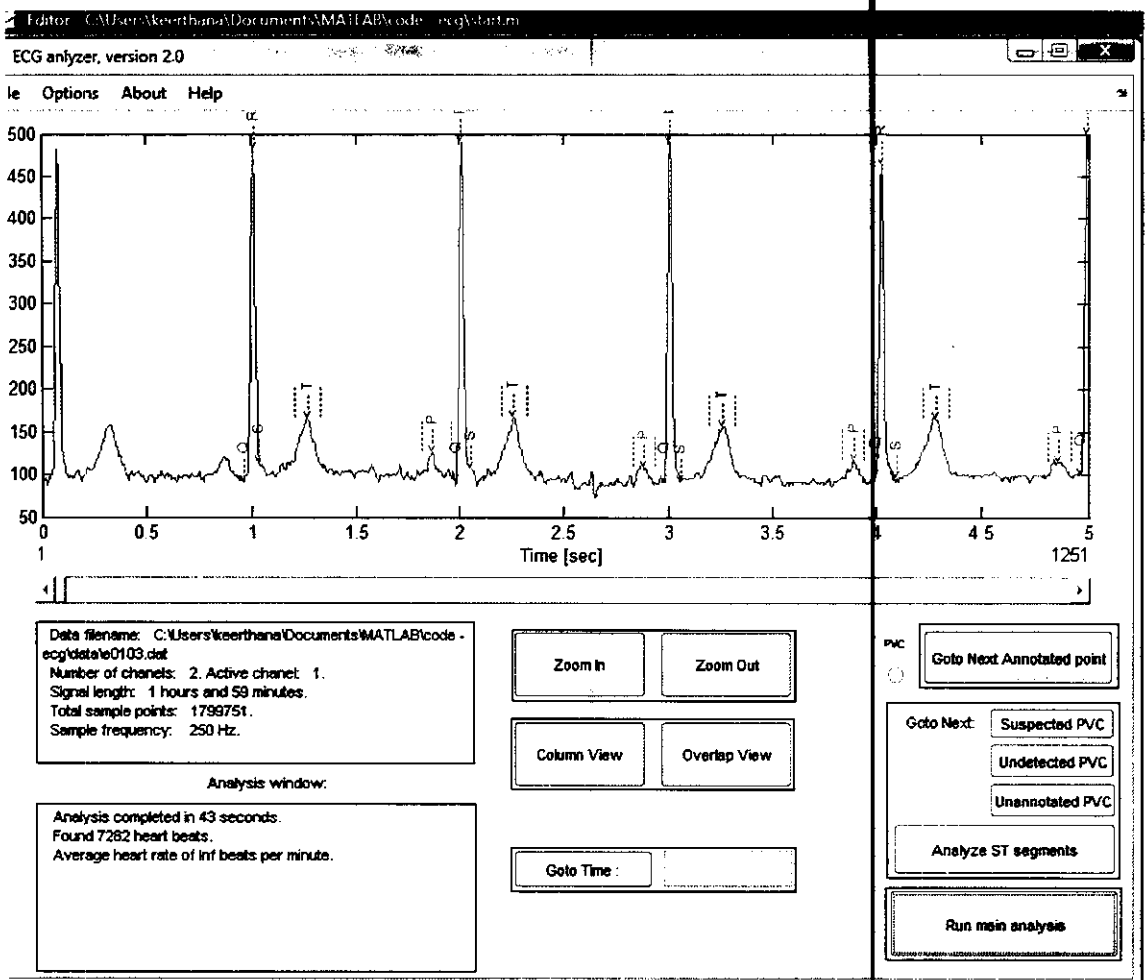

C6
INPUT: PT_WDATA, T PEAK
OUTPUT: T ONSET,T OFFSET
i =1
A3
LOC= PEAK (i)
DAT
A(LOC>0)&
(LOC>=1)
NO
ONSET=
LOC
YES
LOC--
B12


B12
LOC=PEAK(i)
DATA
(LOC>0)&
(LOC<LENGTH)
NO
OFF SET= LOC
YES
LOC= LOC+1
i ++
A3
NO
IF
i=LENGTH(PEAK)
YES
END

4.RESULTS

4. RESULTS

4.1 SIGNAL E0103



Results =

Rpeaks: [253 503 753 1007]

Qpeaks: [241 497 746 1000]

Speaks: [259 515 765 1025]

Tpeaks: [317 567 816]

Tonsets: [301 551 800]

Toffsets: [331 582 831]

Ppeaks: [468 722 974]

RR interval > 1s; Name of abnormality: Bradycardia

QRS interval < 0.1s; Name of abnormality: Hypercalcaemia

is P wave present : Y or N

'Y'

P wave absent: Abnormality is Hyperkalemia

is the P wave inverted : Y or N

'N'

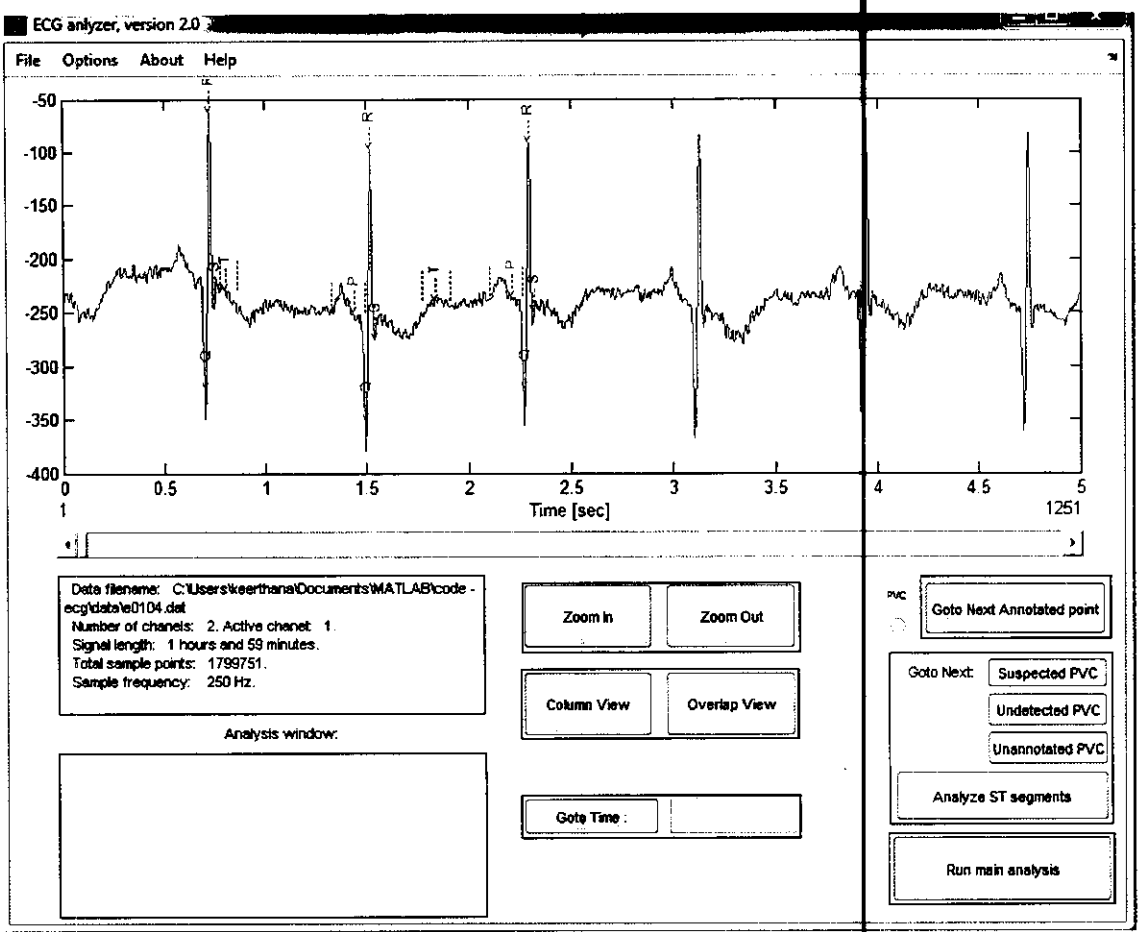
P wave not inverted :No Dextrocardia

is the T wave inverted : Y or N

'N'

T wave not inverted :No Myocardial ischaemia

4.2 SIGNAL E0104



Results =

Rpeaks: [183 380 575]

Qpeaks: [178 376 570]

Speaks: [189 386 581]

Tpeaks: [202 459]

Tonsets: [195 443]

Toffsets: [216 478]

Ppeaks: [360 554]

RR interval < 0.6s; Name of abnormality: tachycardia

QRS interval < 0.1s; Name of abnormality: Hypercalcaemia

is P wave present : Y or N

'Y'

P wave absent: Abnormality is Hyperkalemia

is the P wave inverted : Y or N

'N'

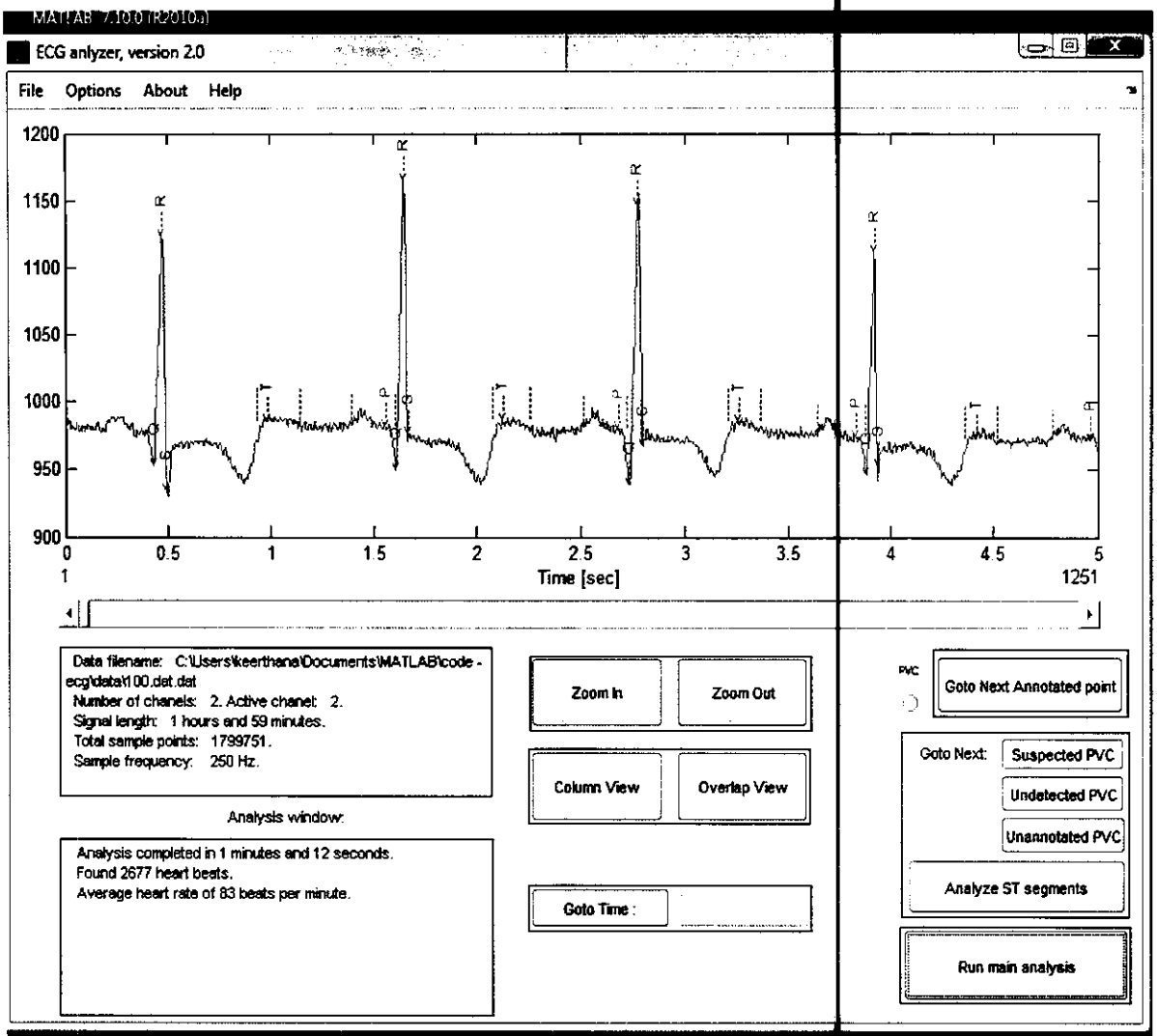
P wave not inverted :No Dextrocardia

is the T wave inverted : Y or N

'N'

T wave not inverted :No Myocardial ischaemia

4.3 SIGNAL MITBIH 100



Results =

Rpeaks: [119 412 695 980]

Qpeaks: [109 402 685 971]

Speaks: [125 418 701 986]

Tpeaks: [247 532 815]

Tonsets: [234 520 802]

Toffsets: [286 564 842]

Ppeaks: [390 671 958]

RR interval > 1s; Name of abnormality: Bradycardia

QRS interval < 0.1s; Name of abnormality: Hypercalcaemia

is P wave present : Y or N

'Y'

P wave absent: Abnormality is Hyperkalemia

is the P wave inverted : Y or N

'N'

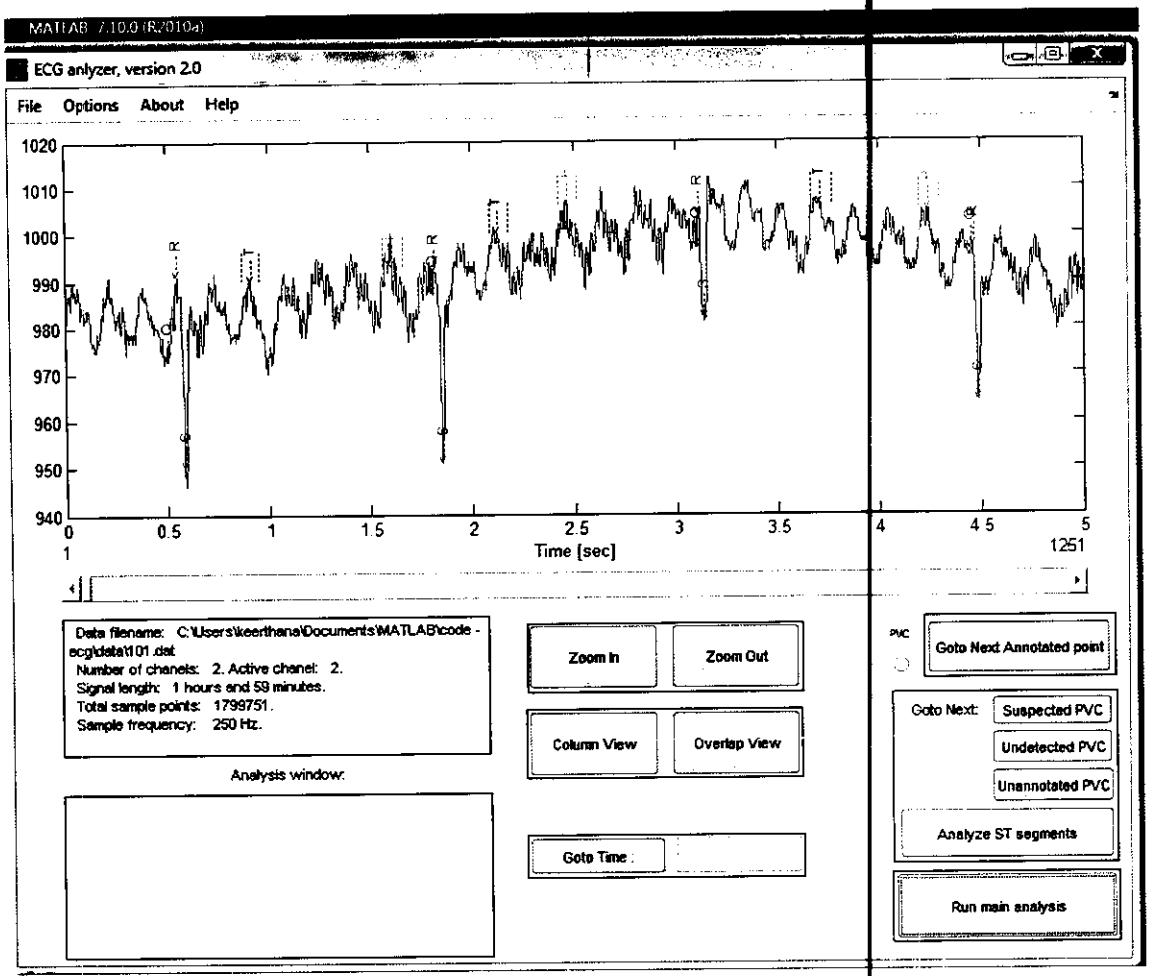
P wave not inverted :No Dextrocardia

is the T wave inverted : Y or N

'N'

T wave not inverted :No Myocardial ischaemia

4.4 SIGNAL MITBIH 101



Results =

Rpeaks: [139 455 779 1116]

Qpeaks: [128 453 776 1114]

Speaks: [148 464 785 1122]

Tpeaks: [229 533 929]

Tonsets: [218 522 917]

Toffsets: [240 545 943]

Ppeaks: [403 618 1062]

RR interval > 1s; Name of abnormality: Bradycardia

QRS interval < 0.1s; Name of abnormality: Hypercalcaemia

is P wave present : Y or N

'Y'

P wave absent: Abnormality is Hyperkalemia

is the P wave inverted : Y or N

'N'

P wave not inverted :No Dextrocardia

is the T wave inverted : Y or N

'N'

T wave not inverted :No Myocardial ischaemia

4.5 VARIABLES

A = NaN

AnalysisConfig = QSpeaks: 1

PTwaves: 1

Assess: 1

UseFreq: 1

freq: 250

Data filename: C:\Users\keerthana\Documents\MATLAB\code - ecg\data\101.dat

Number of chanels: 2. Active chanel: 2.

Signal length: 1 hours and 59 minutes.

Total sample points: 1799751.

Sample frequency: 250 Hz.

PVC_ann_only = 0

QRS = 0.0800

Tanalysis = 0

ViewConfig = Rpeaks: 1

QSpeaks: 1

Twaves: 1

Pwaves: 1

Suspected: 1

Grid: 0

ShowFiltered: 1

align =center

analysis = 0

analysis_segment = 60

annShift = 185

ecg_fname =101

end_point = 1251

estimated_time = 248

filtered =NaN

freq = 250

long_analysis_segment = 600

long_ecg_signal = 600

m =4

max_time_to_show = 20

min_time_to_show = 1

myDebug =0

plotted =

Columns 1 through 9

0 0.0040 0.0080 0.0120 0.0160 0.0200 0.0240 0.0280 0.0320

Columns 10 through 18

0.0360 0.0400 0.0440 0.0480 0.0520 0.0560 0.0600 0.0640 0.0680

results =

Rpeaks: [139 455 779 1116]

Qpeaks: [128 453 776 1114]

Speaks: [148 464 785 1122]

Tpeaks: [229 533 929]

Tonsets: [218 522 917]

Toffsets: [240 545 943]

Ppeaks: [403 618 1062]

Ponsets: [391 606 1050]

Poffsets: [415 630 1074]

Tsuspected: []

Psuspected: []

Ssuspected: []

short_ecg = 60

start_point =1

th = NaN

th_factor = 0.3000

time_to_show = 5

t =n

total_time = 7199

transformed = 0

wdata = NaN

zoom_rate = 1

run_full =No

data = 1024

1024

1024

1024

Sample No	Bradycardia/ Tachycardia	Hypercalcaemia	Hyperkalemia	Dextrocardia	Myocardial ischaemia
e0103	Bradycardia	Yes	No	No	No
e0104	Tachycardia	Yes	No	No	No
e0105	Bradycardia	No	No	No	No
e0106	Bradycardia	Yes	No	No	No
e0107	Bradycardia	Yes	No	No	No
e0108	Bradycardia	Yes	No	No	No
e0110	Tachycardia	Yes	No	No	No
e0113	Tachycardia	Yes	No	No	No
e0817	Bradycardia	Yes	No	No	No
e0818	Tachycardia	Yes	No	No	No
mitbih100	Bradycardia	Yes	No	No	No
mitbih 101	Bradycardia	Yes	No	No	No
mitbih 102	Bradycardia	Yes	No	No	No
mitbih 103	Bradycardia	Yes	No	No	No
mitbih 104	Bradycardia	Yes	No	No	No
mitbih 105	Bradycardia	Yes	No	No	No
mitbih 106	Tachycardia	Yes	No	No	No
mitbih 107	Bradycardia	No	No	No	No
mitbih 108	Bradycardia	Yes	No	No	No
mitbih 109	Tachycardia	Yes	No	No	No
mitbih 111	Bradycardia	Yes	No	No	No
mitbih 112	Bradycardia	Yes	No	No	No
mitbih 113	Bradycardia	No	No	No	No
mitbih 114	Bradycardia	No	No	No	No
mitbih 116	Bradycardia	Yes	No	No	No
mitbih 117	Bradycardia	Yes	No	No	No
mitbih 118	Bradycardia	Yes	No	No	No
mitbih 119	Bradycardia	No	No	No	No
mitbih 121	Bradycardia	Yes	No	No	No
mitbih 122	Bradycardia	Yes	No	No	No
mitbih 123	Bradycardia	No	No	No	No
mitbih 124	Bradycardia	Yes	No	No	No
mitbih 200	Tachycardia	Yes	No	No	No
mitbih 201	Bradycardia	Yes	No	No	No
mitbih 202	Bradycardia	Yes	No	No	No
mitbih 203	Tachycardia	Yes	No	No	No
mitbih 205	Tachycardia	Yes	No	No	No
mitbih 207	Tachycardia	No	Yes	No	No
st 16252	Tachycardia	No	No	No	No

Table 3: Analysis of samples.

5. CONCLUSION

Wavelet transform based ECG detection performs accurate detection of peaks and boundaries of P,Q,R,S and T waves using Continuous Wavelet Transform. With these the following diseases were identified more accurately.

- Bradycardia
- Tachycardia
- Hypercalcaemia
- Hyperkalemia
- Dextrocardia
- Myocardial Ischemia

6. FUTURE SCOPE

In the near future many more arrhythmias can be detected from analysing ECG signal. Also the next step in this project is the signal delineation and classification of ECG signal. This can be implemented in hospitals and medical centers where this project would be extremely useful in detecting arrhythmias more easily.

Dr. N. BHASKAR M.D., D.M.,
CONSULTANT CARDIOLOGIST
BKR METRO HEART CENTRE
37, TANK ROAD, SIVANANDA COLONY,
COIMBATORE - 641 012.

✆ Clinic : 0422-2492577
0422-2495277

✆ Resi : 0422-2312577
Mobile : 98430 22044

14.4.11.

To whom so ever it may concern.

This is to certify that I have perused the Project Report done by Ms. B. BHAVANA V. ARUNADEVI, S. DHIVYA KUMARI, B. KEERTHANA of Kumaraguru College of Technology, Coimbatore 49 on ECG Signal Analysis using wavelet Transform. This technique is found to be useful for proper identification of P, QRS, T wave morphology in the ECG. It helps to reduce the artefacts and increase the signal to noise ratio. It is very useful for the diagnosis of clinical conditions like Tachycardia Bradycardia, Hyperkalemia, Hypercalcemia

myocardial Ischemia and Dextrocardia.

29972

Dr. N. BHASKAR M.D., D.M.,
CARDIOLOGIST
BKR METRO HEART CENTRE
37, TANK ROAD, SIVANANDA COLONY,
COIMBATORE - 641 012