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RESEARCH PAPER

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DEMONSTRATING ELECTROCARDIOGRAM (ECG) SIGNAL PROCESSING TO SHOW NONLINEAR ABNORMALITIES OF THE HEART

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Abstract: Heart beat classification is considered as the main tool for recognizing and diagnosing different heart diseases. The shape and size of these waves, the time between each wave and the rate and regularity of the heartbeat provide valuable information to doctors. An electrocardiogram, also called an ECG or EKG, is a quick, painless test that measures the heart's electrical activity and records any disturbances in heart rhythm. The paper aimed at demonstrating electrocardiogram (ECG) signal processing to show the nonlinear abnormalities of the heart using Microsoft Excel. The study will definitely enhance fast and cost effective diagnosis of Ischemic Episodes.

Keywords*:* Electrocardiogram, Arrhythmia, Heart Rhythm, Heart Anatomy, Cardiac Disorder**.**

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I. INTRODUCTION

The human heart is an organ that pumps blood throughout the body using the circulatory system, removing carbon dioxide and wastes, and giving oxygen and nutrients to the tissues [1]. An abnormality of the heart is when the human heart beats too fast, slow, or irregularly [2]. It is called arrhythmia. The heart contains a complex system of values, nodes, and chambers that controls when and how the blood pumps [2].

There are different types of abnormal heart beat; they are: Atrial Fibrillation and Flutter, Congestive Heart Failure (CHF), Congestive (Dilated) Cardiomyopathy, Mitral Value Prolapse, Hypertensive Heart Disease, Cardiogenic Shock, Dissection of the Aorta, Hypokalemia, Hyperthyroidism, Anaphylaxis, Hypoglycemia (low blood sugar), Hypothyroidism, Aortic Coarctation, Ventricular Septal Defects [2]. The abnormal heart beat has various types. These ones mentioned are just few of it [2].

The abnormal heart beat considered here is the Ischemic Episodes. The word ischemia means heart stroke. It is a cardiovascular disorder which affects the heart and the blood vessels. The coronary arteries become narrowed by atherosclerosis which restricts the flow of blood and oxygen to the heart and brain. This makes brain cells to die which creates cardiac disorder or cardiac arrhythmias known as ischemia [3]. In detecting this heart disorder, the process takes longer if analyzed by the doctor using long duration ECG data. The key to ischemic episodes detection is the ST-segment deviation and T-wave Amplitude changes [4].

This work aimed at demonstrating electrocardiogram (ECG) signal processing to show the nonlinear abnormalities of the heart using Microsoft Excel.

A. Medical Background of the Heart

The heart consists of four chambers, two upper (the atria) and two lower (the ventricles) as shown in figure 1. The heart is a powerful muscle that lies in the chest. The heart beat is the physical contraction of the heart muscle for pumping blood [5].

Abnormal heart rhythms is when an individual has an abnormal heart rhythm. It happens when an individual's heart electrical system breaks down or malfunctions. This may be a symptom of underlying coronary heart disease or other medical problems [6]. The causes of arrhythmias are: irritable heart cells, blocked signals, abnormal pathway, medicines and stimulants, coronary artery spasm (prinzmetalangina). Diagnosis of arrhythmias is done using electrocardiography (ECG) and Tilt Tests [6]. ECG shows the doctor how the electrical system in the heart works. Tilt tests helps the doctor to know whether or not different body positions will trigger an arrhythmia. They are useful for investigating the hearts of people who faint without explanation [6].

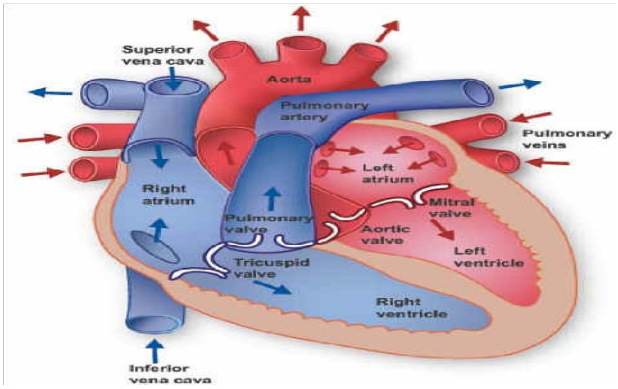

Figure 1. Hart Anatomy [7]

B. Overview of an Abnormal Heart

The heart is a muscular organ with four chambers designed to work efficiently, reliably, and continuously over a lifetime. The muscular walls of each chamber contract in a regulated sequence, pumping blood as required by the body while expending as little energy as possible during each heartbeat [8].

Heart disorders are the most common cause of an abnormal heart rhythm. Sometimes people are aware of abnormal heart rhythms, but many times they feel only their consequences, such as weakness or fainting [8]. The diagnosis is based on electrocardiography. Treatment involves restoring the heart to a normal rhythm and preventing further episodes.

Contraction of the muscle fibers in the heart is controlled by electricity that flows through the heart in a precise manner along distinct pathways at a controlled speed [8]. The electrical current that begins each heartbeat originates in the heart's pacemaker (called the sinus node or sino atrial node), located in the top of the upper right heart chamber (right atrium). The rate at which the pacemaker discharges the electrical current determines the heart rate. This rate is influenced by nerve impulses and by levels of certain hormones in the bloodstream.

C. Conduction Systems

The heart rate is regulated automatically by the autonomic nervous system, which consists of the sympathetic and parasympathetic divisions [8]. The sympathetic division increases the heart rate through a network of nerves called the sympathetic plexus. The parasympathetic division decreases the heart rate through a single nerve, the vagus nerve.

Heart rate is also influenced by hormones released into the bloodstream by the sympathetic division which is called epinephrine (adrenaline) and norepinephrine (noradrenaline). This sympathetic division's increases heart rate. Thyroid hormone also increases heart rate when it is been released into the blood stream by the thyroid gland [8].

When an adult is at rest, the normal heart rate is usually between 60 and 100 beats per minute. Lower rates may be normal in young adults, especially those who are physically fit. An individual's heart rate varies normally in response to exercise and such stimuli as pain and anger. Heart rhythm is considered abnormal only when the heart rate is inappropriately fast (called tachycardia), slow (called bradycardia), or irregular or when electrical impulses travel along abnormal pathways [8].

D. Tracing the Heart's Electrical Pathway

The sinoatrial (sinus) node (1) initiates an electrical impulse that flows through the right and left atria (2), making them contract. When the electrical impulse reaches the atrioventricular node (3), it is delayed slightly. The impulse then travels down the bundle of His (4), which divides into the right bundle branch for the right ventricle (5) and the left bundle branch for the left ventricle (5). The impulse then spreads through the ventricles, making them contract [8].

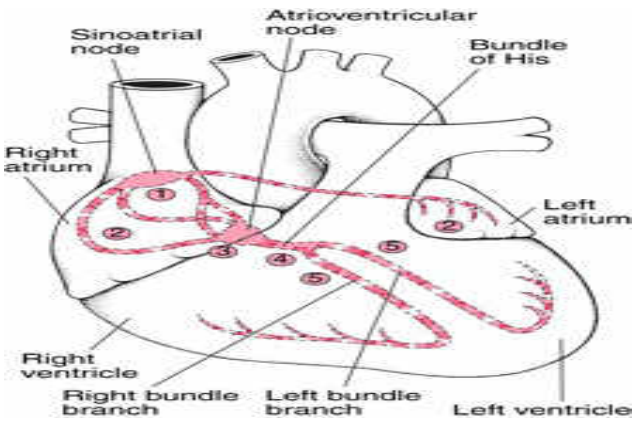

Figure 2. Tracing the Heart's Electrical Pathway [8]

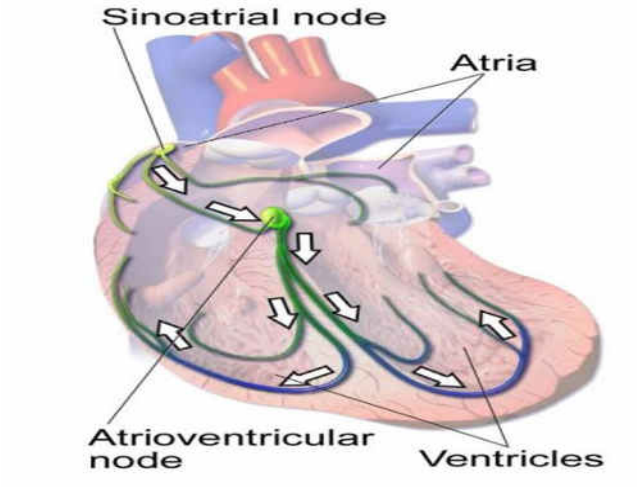

Figure 3. Electrical Conduction System of the Heart [8]

E. Electrical Conduction System of the Heart

The electrical current travels down the bundle of His which is a group of fibers that divide into a left bundle branch for the left ventricle and a right bundle branch for the right ventricle, after passing through the atrioventricular node. The electrical current then spreads in a regulated manner over the surface of the ventricles, from the bottom up, initiating contraction of the ventricles, which eject blood from the heart [8].

F. Electro Cardiogram (ECG)

This is the graphical recording of the electrical signals generated by the heart [9]. ECG was introduced for the first time by Willem Einthoven in 1983 The ECG mainly contains three main signal structure. Cardiac arrhythmias which are results of abnormal heart activity upon certain conditions can be indicated by the change in shape of one of these traces [6]. Placing electrodes (up to 12 electrodes) at various body points is the way in which the ECG can record the electrical activity of the heart [6]. An automation of cardiac arrhythmias using ECG is considered as one of the most important recent fields of research [10] as ECG is considered a reliable tool.

II. DEMONSTRATION OF ECG SIGNAL PROCESSING TO SHOW NON LINEAR ABNORMALITIES OF THE HEART

In order to demonstrate ECG signal processing to show nonlinear abnormalities of the heart, an abnormal heart data set was extracted online from kaggle database. This data contains various fields which includes; age, sex, cp, restbp, chol, fbs, restecg, thalach, exang, oldpeak, slope, and ca. This fields are described further in 2.1.

A. Description of Fields Used in the Abnormal Heart Dataset

The Age is in years, Sex (1= male; 0= female), cp means chest pain type, restbp means resting blood pressure (in mm Hg on admission to the hospital), chol means serum cholestoral in mg/dl, fbs means ((fasting blood sugar > 120 mg/dl), 1=true; 0= false), restecg means resting electrocardiographic results), thalach means ((maximum heart rate achieved), thal 3=normal; 6= fixed defect; 7= reversible defect, target 1 or 0.), exang means (exercise induced angina

(1=yes; 0=no)), oldpeak means ST depression induced by exercise relative to rest, slope means the slope of the peak exercise ST segment, ca means number of major vessels (0-3) coloured by flourosopy. 2.2 shows the abnormal heart dataset.

B. The Abnormal Heart Dataset

Table 1 contains dataset of the abnormal heart. This abnormal heart dataset was extracted as a .csv file (heart.csv), which is a file extension name of Microsoft Excel.

Table I. Abnormal Heart Dataset [11]

S/N	Age	Sex	ChestPain	RestBP	Chol	Fbs	RestECG	MaxHR	ExAng	Oldpeak	Slope	Ca	Thal	AHD
1	63	1	typical	145	233	1	2	150	0	2.3	3	0	fixed	No
2	67	1	asymptomatic	160	286	0	2	108	1	1.5	2	3	normal	Yes
3	67	1	asymptomatic	120	229	0	2	129	1	2.6	2	2	reversable	Yes
4	37	1	nonanginal	130	250	0	0	187	0	3.5	3	0	normal	No
5	41	0	nontypical	130	204	0	2	172	0	1.4	1	0	normal	No
6	56	1	nontypical	120	236	0	0	178	0	0.8	1	0	normal	No
7	62	0	asymptomatic	140	268	0	2	160	0	3.6	3	2	normal	Yes
8	57	0	asymptomatic	120	354	0	0	163	1	0.6	1	0	normal	No
9	63	1	asymptomatic	130	254	0	2	147	0	1.4	2	1	reversable	Yes
10	53	1	asymptomatic	140	203	1	2	155	1	3.1	3	0	reversable	Yes
11	57	1	asymptomatic	140	192	0	0	148	0	0.4	2	0	fixed	No
12	56	0	nontypical	140	294	0	2	153	0	1.3	2	0	normal	No
13	56	1	nonanginal	130	256	1	2	142	1	0.6	2	1	fixed	Yes
14	44	1	nontypical	120	263	0	0	173	0	0	1	0	reversable	No
15	52	1	nonanginal	172	199	1	0	162	0	0.5	1	0	reversable	No
16	57	1	nonanginal	150	168	0	0	174	0	1.6	1	0	normal	No
17	48	1	nontypical	110	229	0	0	168	0	1	3	0	reversable	Yes
18	54	1	asymptomatic	140	239	0	0	160	0	1.2	1	0	normal	No
19	48	0	nonanginal	130	275	0	0	139	0	0.2	1	0	normal	No
20	49	1	nontypical	130	266	0	0	171	0	0.6	1	0	normal	No
21	64	1	typical	110	211	0	2	144	1	1.8	2	0	normal	No
22	58	0	typical	150	283	1	2	162	0	1	1	0	normal	No
23	58	1	nontypical	120	284	0	2	160	0	1.8	2	0	normal	Yes
24	58	1	nonanginal	132	224	0	2	173	0	3.2	1	2	reversable	Yes
25	60	1	asymptomatic	130	206	0	2	132	1	2.4	2	2	reversable	Yes
26	50	0	nonanginal	120	219	0	0	158	0	1.6	2	0	normal	No
27	58	0	nonanginal	120	340	0	0	172	0	0	1	0	normal	No
28	66	0	typical	150	226	0	0	114	0	2.6	3	0	normal	No
29	43	1	asymptomatic	150	247	0	0	171	0	1.5	1	0	normal	No
30	40	1	asymptomatic	110	167	0	2	114	1	2	2	0	reversable	Yes
31	69	0	typical	140	239	0	0	151	0	1.8	1	2	normal	No
32	60	1	asymptomatic	117	230	1	0	160	1	1.4	1	2	reversable	Yes
33	64	1	nonanginal	140	335	0	0	158	0	0	1	0	normal	Yes
34	59	1	asymptomatic	135	234	0	0	161	0	0.5	2	0	reversable	No
35	44	1	nonanginal	130	233	0	0	179	1	0.4	1	0	normal	No
36	42	1	asymptomatic	140	226	0	0	178	0	0	1	0	normal	No
37	43	1	asymptomatic	120	177	0	2	120	1	2.5	2	0	reversable	Yes
38	57	1	asymptomatic	150	276	0	2	112	1	0.6	2	1	fixed	Yes
39	55	1	asymptomatic	132	353	0	0	132	1	1.2	2	1	reversable	Yes
40	61	1	nonanginal	150	243	1	0	137	1	1	2	0	normal	No
41	65	0	asymptomatic	150	225	0	2	114	0	1	2	3	reversable	Yes
42	40	1	typical	140	199	0	0	178	1	1.4	1	0	reversable	No
43	71	0	nontypical	160	302	0	0	162	0	0.4	1	2	normal	No
44	59	1	nonanginal	150	212	1	0	157	0	1.6	1	0	normal	No
45	61	0	asymptomatic	130	330	0	2	169	0	0	1	0	normal	Yes
46	58	1	nonanginal	112	230	0	2	165	0	2.5	2	1	reversable	Yes
47	51	1	nonanginal	110	175	0	0	123	0	0.6	1	0	normal	No
48	50	1	asymptomatic	150	243	0	2	128	0	2.6	2	0	reversable	Yes
49	65	0	nonanginal	140	417	1	2	157	0	0.8	1	1	normal	No
50	53	1	nonanginal	130	197	1	2	152	0	1.2	3	0	normal	No
51	41	0	nontypical	105	198	0	0	168	0	0	1	1	normal	No
52	65	1	asymptomatic	120	177	0	0	140	0	0.4	1	0	reversable	No
53	44	1	asymptomatic	112	290	0	2	153	0	0	1	1	normal	Yes
54	44	1	nontypical	130	219	0	2	188	0	0	1	0	normal	No
55	60	1	asymptomatic	130	253	0	0	144	1	1.4	1	1	reversable	Yes
56	54	1	asymptomatic	124	266	0	2	109	1	2.2	2	1	reversable	Yes
57	50	1	nonanginal	140	233	0	0	163	0	0.6	2	1	reversable	Yes
58	41	1	asymptomatic	110	172	0	2	158	0	0	1	0	reversable	Yes
59	54	1	nonanginal	125	273	0	2	152	0	0.5	3	1	normal	No
60	51	1	typical	125	213	0	2	125	1	1.4	1	1	normal	No
61	51	0	asymptomatic	130	305	0	0	142	1	1.2	2	0	reversable	Yes
62	46	0	nonanginal	142	177	0	2	160	1	1.4	3	0	normal	No
63	58	1	asymptomatic	128	216	0	2	131	1	2.2	2	3	reversable	Yes
64	54	0	nonanginal	135	304	1	0	170	0	0	1	0	normal	No
65	54	1	asymptomatic	120	188	0	0	113	0	1.4	2	1	reversable	Yes
66	60	1	asymptomatic	145	282	0	2	142	1	2.8	2	2	reversable	Yes
67	60	1	nonanginal	140	185	0	2	155	0	3	2	0	normal	Yes
68	54	1	nonanginal	150	232	0	2	165	0	1.6	1	0	reversable	No
69	59	1	asymptomatic	170	326	0	2	140	1	3.4	3	0	reversable	Yes
70	46	1	nonanginal	150	231	0	0	147	0	3.6	2	0	normal	Yes
71	65	0	nonanginal	155	269	0	0	148	0	0.8	1	0	normal	No
72	67	1	asymptomatic	125	254	1	0	163	0	0.2	2	2	reversable	Yes
73	62	1	asymptomatic	120	267	0	0	99	1	1.8	2	2	reversable	Yes
74	65	1	asymptomatic	110	248	0	2	158	0	0.6	1	2	fixed	Yes
75	44	1	asymptomatic	110	197	0	2	177	0	0	1	1	normal	Yes
76	65	0	nonanginal	160	360	0	2	151	0	0.8	1	0	normal	No
77	60	1	asymptomatic	125	258	0	2	141	1	2.8	2	1	reversable	Yes
78	51	0	nonanginal	140	308	0	2	142	0	1.5	1	1	normal	No
79	48	1	nontypical	130	245	0	2	180	0	0.2	2	0	normal	No
80	58	1	asymptomatic	150	270	0	2	111	1	0.8	1	0	reversable	Yes
81	45	1	asymptomatic	104	208	0	2	148	1	3	2	0	normal	No
82	53	0	asymptomatic	130	264	0	2	143	0	0.4	2	0	normal	No
83	39	1	nonanginal	140	321	0	2	182	0	0	1	0	normal	No
84	68	1	nonanginal	180	274	1	2	150	1	1.6	2	0	reversable	Yes
85	52	1	nontypical	120	325	0	0	172	0	0.2	1	0	normal	No
86	44	1	nonanginal	140	235	0	2	180	0	0	1	0	normal	No
87	47	1	nonanginal	138	257	0	2	156	0	0	1	0	normal	No
88	53	0	nonanginal	128	216	0	2	115	0	0	1	0	NA	No
89	53	0	asymptomatic	138	234	0	2	160	0	0	1	0	normal	No
90	51	0	nonanginal	130	256	0	2	149	0	0.5	1	0	normal	No
91	66	1	asymptomatic	120	302	0	2	151	0	0.4	2	0	normal	No
92	62	0	asymptomatic	160	164	0	2	145	0	6.2	3	3	reversable	Yes
93	62	1	nonanginal	130	231	0	0	146	0	1.8	2	3	reversable	No
94	44	0	nonanginal	108	141	0	0	175	0	0.6	2	0	normal	No
95	63	0	nonanginal	135	252	0	2	172	0	0	1	0	normal	No
96	52	1	asymptomatic	128	255	0	0	161	1	0	1	1	reversable	Yes
97	59	1	asymptomatic	110	239	0	2	142	1	1.2	2	1	reversable	Yes
98	60	0	asymptomatic	150	258	0	2	157	0	2.6	2	2	reversable	Yes
99	52	1	nontypical	134	201	0	0	158	0	0.8	1	1	normal	No
100	48	1	asymptomatic	122	222	0	2	186	0	0	1	0	normal	No
101	45	1	asymptomatic	115	260	0	2	185	0	0	1	0	normal	No
102	34	1	typical	118	182	0	2	174	0	0	1	0	normal	No
103	57	0	asymptomatic	128	303	0	2	159	0	0	1	1	normal	No
104	71	0	nonanginal	110	265	1	2	130	0	0	1	1	normal	No
105	49	1	nonanginal	120	188	0	0	139	0	2	2	3	reversable	Yes
106	54	1	nontypical	108	309	0	0	156	0	0	1	0	reversable	No
107	59	1	asymptomatic	140	177	0	0	162	1	0	1	1	reversable	Yes
108	57	1	nonanginal	128	229	0	2	150	0	0.4	2	1	reversable	Yes
109	61	1	asymptomatic	120	260	0	0	140	1	3.6	2	1	reversable	Yes
110	39	1	asymptomatic	118	219	0	0	140	0	1.2	2	0	reversable	Yes
111	61	0	asymptomatic	145	307	0	2	146	1	1	2	0	reversable	Yes
112	56	1	asymptomatic	125	249	1	2	144	1	1.2	2	1	normal	Yes
113	52	1	typical	118	186	0	2	190	0	0	2	0	fixed	No
114	43	0	asymptomatic	132	341	1	2	136	1	3	2	0	reversable	Yes
115	62	0	nonanginal	130	263	0	0	97	0	1.2	2	1	reversable	Yes
116	41	1	nontypical	135	203	0	0	132	0	0	2	0	fixed	No
117	58	1	nonanginal	140	211	1	2	165	0	0	1	0	normal	No
118	35	0	asymptomatic	138	183	0	0	182	0	1.4	1	0	normal	No
119	63	1	asymptomatic	130	330	1	2	132	1	1.8	1	3	reversable	Yes
120	65	1	asymptomatic	135	254	0	2	127	0	2.8	2	1	reversable	Yes
121	48	1	asymptomatic	130	256	1	2	150	1	0	1	2	reversable	Yes
122	63	0	asymptomatic	150	407	0	2	154	0	4	2	3	reversable	Yes
123	51	1	nonanginal	100	222	0	0	143	1	1.2	2	0	normal	No
124	55	1	asymptomatic	140	217	0	0	111	1	5.6	3	0	reversable	Yes
125	65	1	typical	138	282	1	2	174	0	1.4	2	1	normal	Yes
126	45	0	nontypical	130	234	0	2	175	0	0.6	2	0	normal	No
127	56	0	asymptomatic	200	288	1	2	133	1	4	3	2	reversable	Yes
128	54	1	asymptomatic	110	239	0	0	126	1	2.8	2	1	reversable	Yes
129	44	1	nontypical	120	220	0	0	170	0	0	1	0	normal	No
130	62	0	asymptomatic	124	209	0	0	163	0	0	1	0	normal	No
131	54	1	nonanginal	120	258	0	2	147	0	0.4	2	0	reversable	No
132	51	1	nonanginal	94	227	0	0	154	1	0	1	1	reversable	No
133	29	1	nontypical	130	204	0	2	202	0	0	1	0	normal	No
134	51	1	asymptomatic	140	261	0	2	186	1	0	1	0	normal	No
135	43	0	nonanginal	122	213	0	0	165	0	0.2	2	0	normal	No
136	55	0	nontypical	135	250	0	2	161	0	1.4	2	0	normal	No

137	70	1 asymptomatic	145	174	0	0	125	1	2.6	3	0 reversable	Yes
138	62	1 nontypical	120	281	0	2	103	0	1.4	2	1 reversable	Yes
139	35	1 asymptomatic	120	198	0	0	130	1	1.6	2	0 reversable	Yes
140	51	1 nonanginal	125	245	1	2	166	0	2.4	2	0 normal	No
141	59	1 nontypical	140	221	0	0	164	1	0	1	0 normal	No
142	59	1 typical	170	288	0	2	159	0	0.2	2	0 reversable	Yes
143	52	1 nontypical	128	205	1	0	184	0	0	1	0 normal	No
144	64	1 nonanginal	125	309	0	0	131	1	1.8	2	0 reversable	Yes
145	58	1 nonanginal	105	240	0	2	154	1	0.6	2	0 reversable	No
146	47	1 nonanginal	108	243	0	0	152	0	0	1	0 normal	Yes
147	57	1 asymptomatic	165	289	1	2	124	0	1	2	3 reversable	Yes
148	41	1 nonanginal	112	250	0	0	179	0	0	1	0 normal	No
149	45	1 nontypical	128	308	0	2	170	0	0	1	0 normal	No
150	60	0 nonanginal	102	318	0	0	160	0	0	1	1 normal	No
151	52	1 typical	152	298	1	0	178	0	1.2	2	0 reversable	No
152	42	0 asymptomatic	102	265	0	2	122	0	0.6	2	0 normal	No
153	67	0 nonanginal	115	564	0	2	160	0	1.6	2	0 reversable	No
154	55	1 asymptomatic	160	289	0	2	145	1	0.8	2	1 reversable	Yes
155	64	1 asymptomatic	120	246	0	2	96	1	2.2	3	1 normal	Yes
156	70	1 asymptomatic	130	322	0	2	109	0	2.4	2	3 normal	Yes
157	51	1 asymptomatic	140	299	0	0	173	1	1.6	1	0 reversable	Yes
158	58	1 asymptomatic	125	300	0	2	171	0	0	1	2 reversable	Yes
159	60	1 asymptomatic	140	293	0	2	170	0	1.2	2	2 reversable	Yes
160	68	1 nonanginal	118	277	0	0	151	0	1	1	1 reversable	No
161	46	1 nontypical	101	197	1	0	156	0	0	1	0 reversable	No
162	77	1 asymptomatic	125	304	0	2	162	1	0	1	3 normal	Yes
163	54	0 nonanginal	110	214	0	0	158	0	1.6	2	0 normal	No
164	58	0 asymptomatic	100	248	0	2	122	0	1	2	0 normal	No
165	48	1 nonanginal	124	255	1	0	175	0	0	1	2 normal	No
166	57	1 asymptomatic	132	207	0	0	168	1	0	1	0 reversable	No
167	52	1 nonanginal	138	223	0	0	169	0	0	1 NA	normal	No
168	54	0 nontypical	132	288	1	2	159	1	0	1	1 normal	No
169	35	1 asymptomatic	126	282	0	2	156	1	0	1	0 reversable	Yes
170	45	0 nontypical	112	160	0	0	138	0	0	2	0 normal	No
171	70	1 nonanginal	160	269	0	0	112	1	2.9	2	1 reversable	Yes
172	53	1 asymptomatic	142	226	0	2	111	1	0	1	0 reversable	No
173	59	0 asymptomatic	174	249	0	0	143	1	0	2	0 normal	Yes
174	62	0 asymptomatic	140	394	0	2	157	0	1.2	2	0 normal	No
175	64	1 asymptomatic	145	212	0	2	132	0	2	2	2 fixed	Yes
176	57	1 asymptomatic	152	274	0	0	88	1	1.2	2	1 reversable	Yes
177	52	1 asymptomatic	108	233	1	0	147	0	0.1	1	3 reversable	No
178	56	1 asymptomatic	132	184	0	2	105	1	2.1	2	1 fixed	Yes
179	43	1 nonanginal	130	315	0	0	162	0	1.9	1	1 normal	No
180	53	1 nonanginal	130	246	1	2	173	0	0	1	1 normal	No
181	48	1 asymptomatic	124	274	0	2	166	0	0.5	2	0 reversable	Yes
182	56	0 asymptomatic	134	409	0	2	150	1	1.9	2	2 reversable	Yes
183	42	1 typical	148	244	0	2	178	0	0.8	1	2 normal	No
184	59	1 typical	178	270	0	2	145	0	4.2	3	0 reversable	No
185	60	0 asymptomatic	158	305	0	2	161	0	0	1	0 normal	Yes
186	63	0 nontypical	140	195	0	0	179	0	0	1	2 normal	No
187	42	1 nonanginal	120	240	1	0	194	0	0.8	3	0 reversable	No
188	66	1 nontypical	160	246	0	0	120	1	0	2	3 fixed	Yes
189	54	1 nontypical	192	283	0	2	195	0	0	1	1 reversable	Yes
190	69	1 nonanginal	140	254	0	2	146	0	2	2	3 reversable	Yes
191	50	1 nonanginal	129	196	0	0	163	0	0	1	0 normal	No
192	51	1 asymptomatic	140	298	0	0	122	1	4.2	2	3 reversable	Yes
193	43	1 asymptomatic	132	247	1	2	143	1	0.1	2 NA	reversable	Yes
194	62	0 asymptomatic	138	294	1	0	106	0	1.9	2	3 normal	Yes
195	68	0 nonanginal	120	211	0	2	115	0	1.5	2	0 normal	No
196	67	1 asymptomatic	100	299	0	2	125	1	0.9	2	2 normal	Yes
197	69	1 typical	160	234	1	2	131	0	0.1	2	1 normal	No
198	45	0 asymptomatic	138	236	0	2	152	1	0.2	2	0 normal	No
199	50	0 nontypical	120	244	0	0	162	0	1.1	1	0 normal	No
200	59	1 typical	160	273	0	2	125	0	0	1	0 normal	Yes
201	50	0 asymptomatic	110	254	0	2	159	0	0	1	0 normal	No
202	64	0 asymptomatic	180	325	0	0	154	1	0	1	0 normal	No
203	57	1 nonanginal	150	126	1	0	173	0	0.2	1	1 reversable	No
204	64	0 nonanginal	140	313	0	0	133	0	0.2	1	0 reversable	No
205	43	1 asymptomatic	110	211	0	0	161	0	0	1	0 reversable	No
206	45	1 asymptomatic	142	309	0	2	147	1	0	2	3 reversable	Yes
207	58	1 asymptomatic	128	259	0	2	130	1	3	2	2 reversable	Yes
208	50	1 asymptomatic	144	200	0	2	126	1	0.9	2	0 reversable	Yes
209	55	1 nontypical	130	262	0	0	155	0	0	1	0 normal	No
210	62	0 asymptomatic	150	244	0	0	154	1	1.4	2	0 normal	Yes
211	37	0 nonanginal	120	215	0	0	170	0	0	1	0 normal	No
212	38	1 typical	120	231	0	0	182	1	3.8	2	0 reversable	Yes
213	41	1 nonanginal	130	214	0	2	168	0	2	2	0 normal	No
214	66	0 asymptomatic	178	228	1	0	165	1	1	2	2 reversable	Yes
215	52	1 asymptomatic	112	230	0	0	160	0	0	1	1 normal	Yes
216	56	1 typical	120	193	0	2	162	0	1.9	2	0 reversable	No
217	46	0 nontypical	105	204	0	0	172	0	0	1	0 normal	No
218	46	0 asymptomatic	138	243	0	2	152	1	0	2	0 normal	No
219	64	0 asymptomatic	130	303	0	0	122	0	2	2	2 normal	No
220	59	1 asymptomatic	138	271	0	2	182	0	0	1	0 normal	No
221	41	0 nonanginal	112	268	0	2	172	1	0	1	0 normal	No
222	54	0 nonanginal	108	267	0	2	167	0	0	1	0 normal	No
223	39	0 nonanginal	94	199	0	0	179	0	0	1	0 normal	No
224	53	1 asymptomatic	123	282	0	0	95	1	2	2	2 reversable	Yes
225	63	0 asymptomatic	108	269	0	0	169	1	1.8	2	2 normal	Yes
226	34	0 nontypical	118	210	0	0	192	0	0.7	1	0 normal	No
227	47	1 asymptomatic	112	204	0	0	143	0	0.1	1	0 normal	No
228	67	0 nonanginal	152	277	0	0	172	0	0	1	1 normal	No
229	54	1 asymptomatic	110	206	0	2	108	1	0	2	1 normal	Yes
230	66	1 asymptomatic	112	212	0	2	132	1	0.1	1	1 normal	Yes
231	52	0 nonanginal	136	196	0	2	169	0	0.1	2	0 normal	No
232	55	0 asymptomatic	180	327	0	1	117	1	3.4	2	0 normal	Yes
233	49	1 nonanginal	118	149	0	2	126	0	0.8	1	3 normal	Yes
234	74	0 nontypical	120	269	0	2	121	1	0.2	1	1 normal	No
235	54	0 nonanginal	160	201	0	0	163	0	0	1	1 normal	No
236	54	1 asymptomatic	122	286	0	2	116	1	3.2	2	2 normal	Yes
237	56	1 asymptomatic	130	283	1	2	103	1	1.6	3	0 reversable	Yes
238	46	1 asymptomatic	120	249	0	2	144	0	0.8	1	0 reversable	Yes
239	49	0 nontypical	134	271	0	0	162	0	0	2	0 normal	No
240	42	1 nontypical	120	295	0	0	162	0	0	1	0 normal	No
241	41	1 nontypical	110	235	0	0	153	0	0	1	0 normal	No
242	41	0 nontypical	126	306	0	0	163	0	0	1	0 normal	No
243	49	0 asymptomatic	130	269	0	0	163	0	0	1	0 normal	No
244	61	1 typical	134	234	0	0	145	0	2.6	2	2 normal	Yes
245	60	0 nonanginal	120	178	1	0	96	0	0	1	0 normal	No
246	67	1 asymptomatic	120	237	0	0	71	0	1	2	0 normal	Yes
247	58	1 asymptomatic	100	234	0	0	156	0	0.1	1	1 reversable	Yes
248	47	1 asymptomatic	110	275	0	2	118	1	1	2	1 normal	Yes
249	52	1 asymptomatic	125	212	0	0	168	0	1	1	2 reversable	Yes
250	62	1 nontypical	128	208	1	2	140	0	0	1	0 normal	No
251	57	1 asymptomatic	110	201	0	0	126	1	1.5	2	0 fixed	No
252	58	1 asymptomatic	146	218	0	0	105	0	2	2	1 reversable	Yes
253	64	1 asymptomatic	128	263	0	0	105	1	0.2	2	1 reversable	No
254	51	0 nonanginal	120	295	0	2	157	0	0.6	1	0 normal	No
255	43	1 asymptomatic	115	303	0	0	181	0	1.2	2	0 normal	No
256	42	0 nonanginal	120	209	0	0	173	0	0	2	0 normal	No
257	67	0 asymptomatic	106	223	0	0	142	0	0.3	1	2 normal	No
258	76	0 nonanginal	140	197	0	1	116	0	1.1	2	0 normal	No
259	70	1 nontypical	156	245	0	2	143	0	0	1	0 normal	No
260	57	1 nontypical	124	261	0	0	141	0	0.3	1	0 reversable	Yes
261	44	0 nonanginal	118	242	0	0	149	0	0.3	2	1 normal	No
262	58	0 nontypical	136	319	1	2	152	0	0	1	2 normal	Yes
263	60	0 typical	150	240	0	0	171	0	0.9	1	0 normal	No
264	44	1 nonanginal	120	226	0	0	169	0	0	1	0 normal	No
265	61	1 asymptomatic	138	166	0	2	125	1	3.6	2	1 normal	Yes
266	42	1 asymptomatic	136	315	0	0	125	1	1.8	2	0 fixed	Yes
267	52	1 asymptomatic	128	204	1	0	156	1	1	2	0 NA	Yes
268	59	1 nonanginal	126	218	1	0	134	0	2.2	2	1 fixed	Yes
269	40	1 asymptomatic	152	223	0	0	181	0	0	1	0 reversable	Yes
270	42	1 nonanginal	130	180	0	0	150	0	0	1	0 normal	No
271	61	1 asymptomatic	140	207	0	2	138	1	1.9	1	1 reversable	Yes
272	66	1 asymptomatic	160	228	0	2	138	0	2.3	1	0 fixed	No
273	46	1 asymptomatic	140	311	0	0	120	1	1.8	2	2 reversable	Yes
274	71	0 asymptomatic	112	149	0	0	125	0	1.6	2	0 normal	No
275	59	1 typical	134	204	0	0	162	0	0.8	1	2 normal	Yes
276	64	1 typical	170	227	0	2	155	0	0.6	2	0 reversable	No
277	66	0 nonanginal	146	278	0	2	152	0	0	2	1 normal	No
278	39	0 nonanginal	138	220	0	0	152	0	0	2	0 normal	No
279	57	1 nontypical	154	232	0	2	164	0	0	1	1 normal	Yes
280	58	0 asymptomatic	130	197	0	0	131	0	0.6	2	0 normal	No
281	57	1 asymptomatic	110	335	0	0	143	1	3	2	1 reversable	Yes
282	47	1 nonanginal	130	253	0	0	179	0	0	1	0 normal	No
283	55	0 asymptomatic	128	205	0	1	130	1	2	2	1 reversable	Yes
284	35	1 nontypical	122	192	0	0	174	0	0	1	0 normal	No
285	61	1 asymptomatic	148	203	0	0	161	0	0	1	1 reversable	Yes
286	58	1 asymptomatic	114	318	0	1	140	0	4.4	3	3 fixed	Yes
287	58	0 asymptomatic	170	225	1	2	146	1	2.8	2	2 fixed	Yes
288	58	1 nontypical	125	220	0	0	144	0	0.4	2 NA	reversable	No
289	56	1 nontypical	130	221	0	2	163	0	0	1	0 reversable	No

290	56	1 nontypical	120	240	0	0	169	0	0	3	0 normal	No
291	67	1 nonanginal	152	212	0	2	150	0	0.8	2	0 reversable	Yes
292	55	0 nontypical	132	342	0	0	166	0	1.2	1	0 normal	No
293	44	1 asymptomatic	120	169	0	0	144	1	2.8	3	0 fixed	Yes
294	63	1 asymptomatic	140	187	0	2	144	1	4	1	2 reversable	Yes
295	63	0 asymptomatic	124	197	0	0	136	1	0	2	0 normal	Yes
296	41	1 nontypical	120	157	0	0	182	0	0	1	0 normal	No
297	59	1 asymptomatic	164	176	1	2	90	0	1	2	2 fixed	Yes
298	57	0 asymptomatic	140	241	0	0	123	1	0.2	2	0 reversable	Yes
299	45	1 typical	110	264	0	0	132	0	1.2	2	0 reversable	Yes
300	68	1 asymptomatic	144	193	1	0	141	0	3.4	2	2 reversable	Yes
301	57	1 asymptomatic	130	131	0	0	115	1	1.2	2	1 reversable	Yes
302	57	0 nontypical	130	236	0	2	174	0	0	2	1 normal	Yes
303	38	1 nonanginal	138	175	0	0	173	0	0	1 NA	normal	No

C. Demonstration of Abnormal Heart Dataset Using Excel

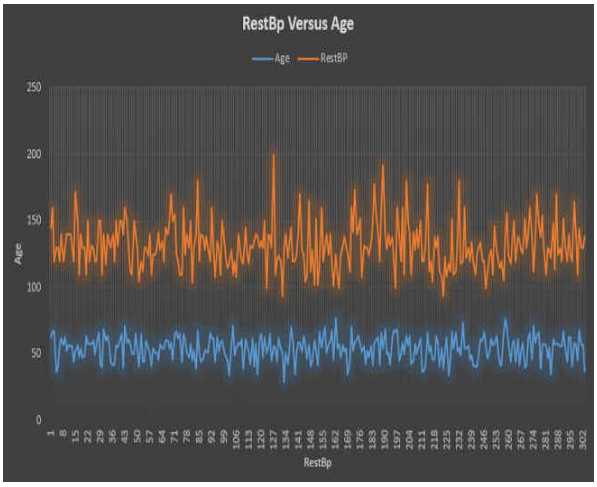

Figure 4. Demonstrating RestBp versus Age

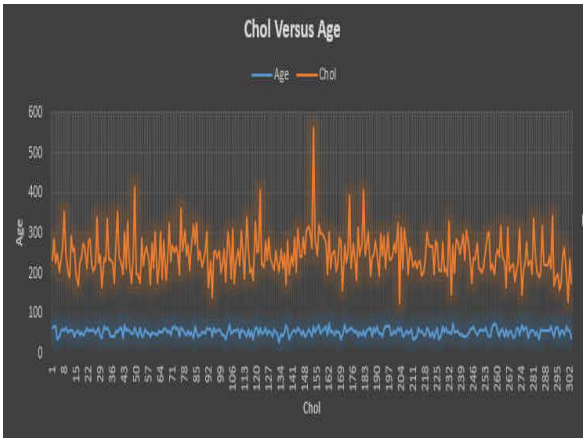

Figure 5. Demonstrating Chol versus Age

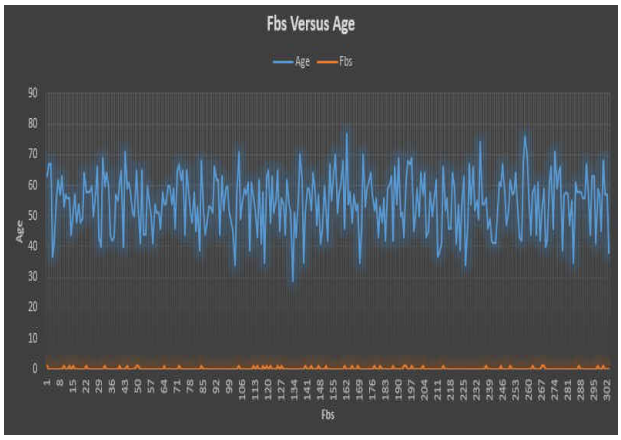

Figure 6. Demonstrating Fbs versus Age

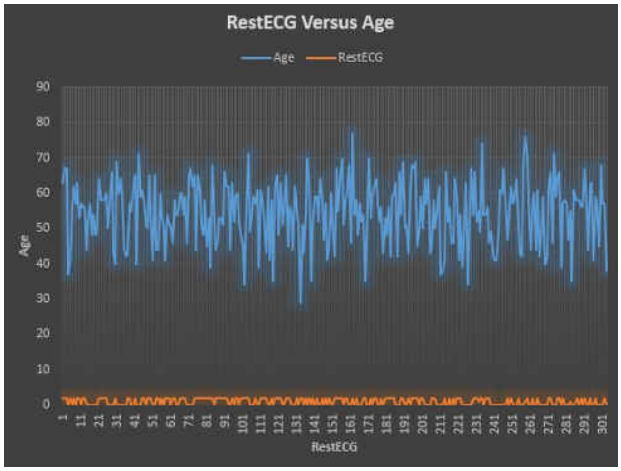

Figure 7. Demonstrating RestECG versus Age

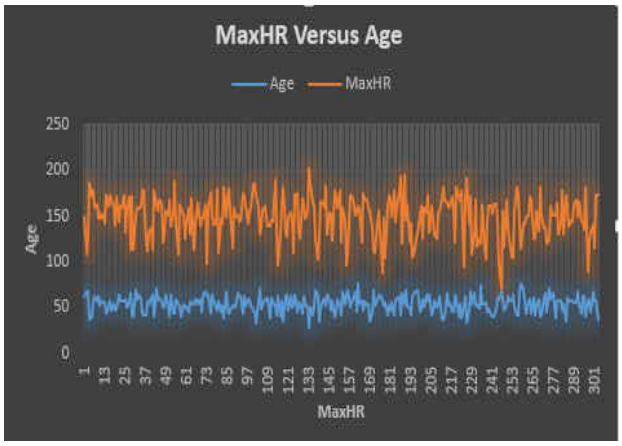

Figure 8. Demonstrating MaxHR versus Age

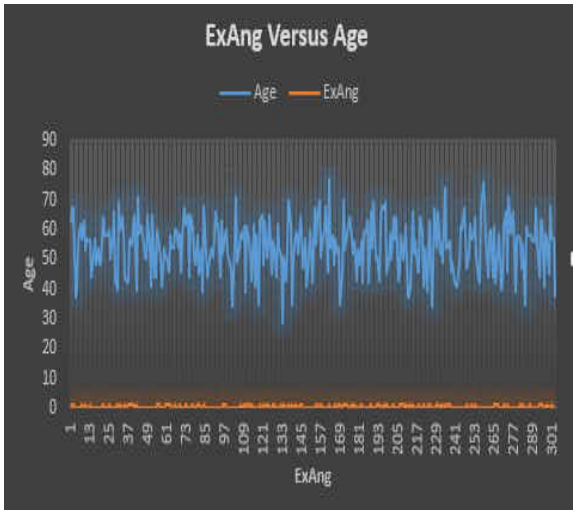

Figure 9. Demonstrating ExAng versus Age

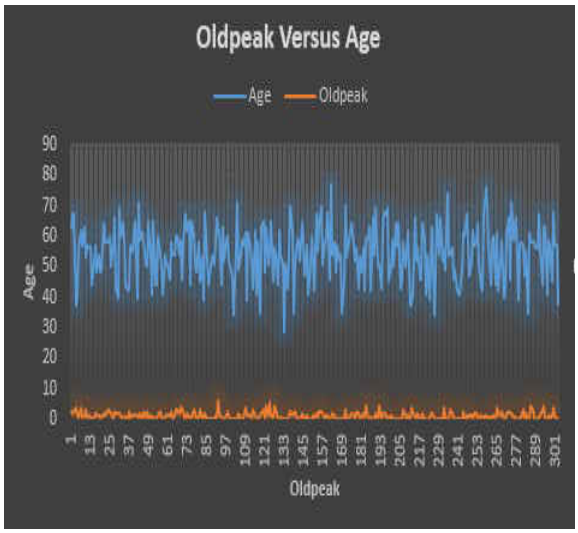

Figure 10. Demonstrating Oldpeak versus Age

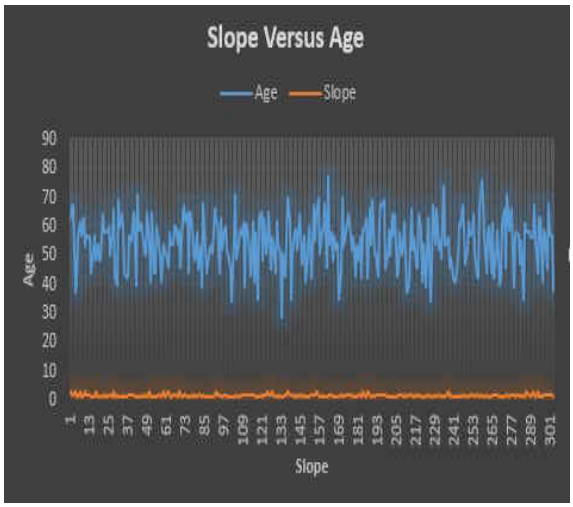

Figure 11. Demonstrating Slope versus Age

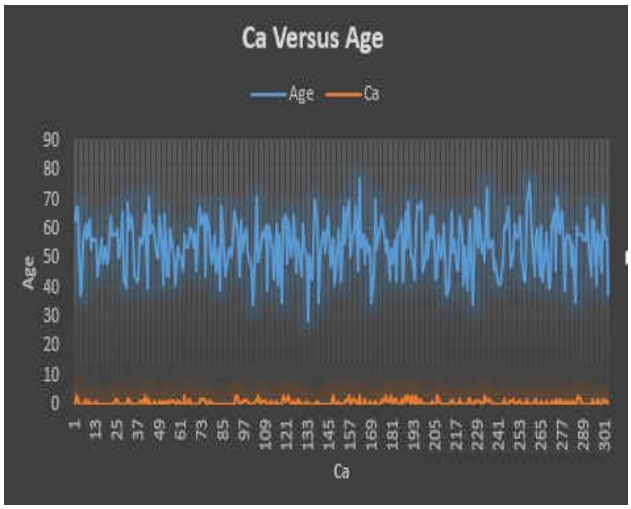

Figure 12. Demonstrating Ca versus Age

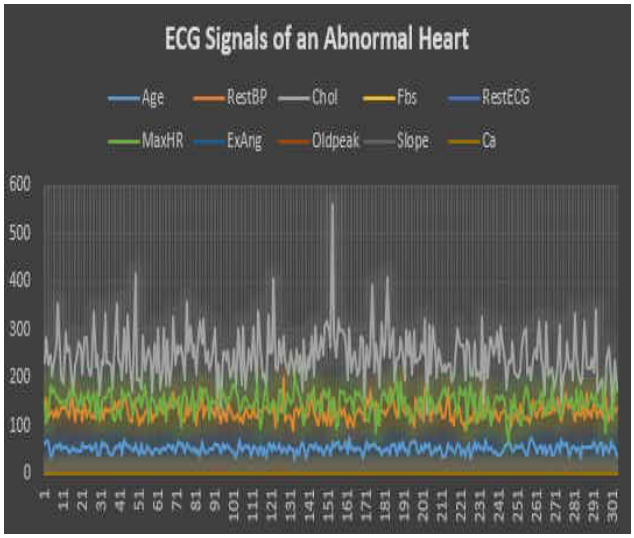

Figure 13. ECG Signals of an Abnormal Heart

III. CONCLUSION

The heart is an important and sensitive organ of the human body and should be prevented from any form of hazardous agent. Every individual should do a routine check of their body system so as to know the health status of their body. That way they can also be able to know the condition of their heart from time to time. The ECG is an important signal among all bioelectrical signals used in the diagnosis of many cardiac disorders and can be recorded from the wave passage of the depolarization and repolarization processes in the heart. The voltage in the heart tissues is conducted to the body surface where it is measured using electrodes. This work demonstrated an ECG Signal Processing of an abnormal heart Using Microsoft Excel. In future this demonstration can be done using Mat Lab or Python programming language. Analysis can also be conducted using any of the machine language model.

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