DEVELOPMENT OF A WEBSITE-BASED FETAL MOVEMENT MONITORING TOOL

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Abstract **Background**: The development of technology by utilizing sensors to record body bioelectricity is a challenge in the transformation of health in the pillar of biotechnology that can be used to detect fetal movement with a non-transmission and inexpensive system. Advances in sensor technology can be used for long-term fetal movement recording. This study discusses the development of a system that can be used by pregnant women to monitor fetal movement using an accelerometer that has a fairly high accuracy in detecting fetal movement. Mobile phone applications to monitor fetal movement using an accelerometer in areas with limited resources have a fairly high level of accuracy and can be used as a tool in monitoring fetal movement. Research on fetal movement recording devices can provide valuable information about the condition of the fetus and its health, and has developed into a reliable technology that can be used in clinical settings.
Objective: to develop a website-based fetal recording device.
Method: The research method used is the research and development (R&D) method, this method is used to develop certain products and test the effectiveness of the product.
Results: The results displayed in the software are in the form of excel which will be processed into a logarithm of fetal movement recorded by the electrode and then an analysis of fetal movement signals will be carried out compared to the movement results from the mother's perception.
Conclusion: The prototype demonstrates superior noise reduction capabilities but may require optimized preprocessing to preserve event-related signal variations.

Keywords: Fetal movement monitoring, website based, transformasi digital

BACKGROUND

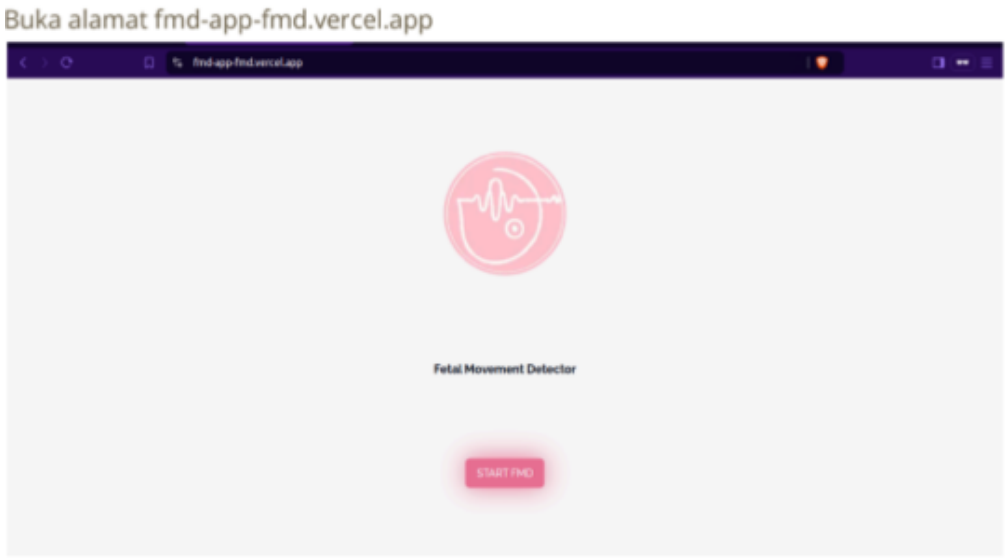
Indicators of maternal and child health success are decreasing maternal and newborn morbidity and mortality. One of the efforts made to reduce infant mortality caused by fetal hypoxia in the womb is by monitoring fetal well-being in the womb. Several variables that are used as parameters to determine fetal well-being are fetal heart rate and fetal movement of less than 3 body or limb movements. [1] Around 55-63% of fetal deaths in the womb are preceded by decreased fetal movement and felt by the mother. [2, 3, 4]
The most commonly used fetal movement quantification method is through maternal perception, this method is highly dependent on the mother, especially fine or gentle movements. [5.] Strong fetal movements are felt by most women at night (72.8%, n = 195) and at night including sleep time (74.5%, n = 199). Women are more likely to feel moderate or strong fetal movements when sitting quietly than when doing other activities such as drinking a cold drink or eating.[6 7.] Research suggests that only about 40% of movements observed on ultrasound are detected by maternal sensation, but there is a lack of clear guidance on what constitutes a perceived movement.[8 9 10 11 12.] Maternal perception accounts for 40% to 90% of fetal movements detected using ultrasound.[13] Because of the inconsistency of maternal perception, a Cochrane review5 reported that four studies involving 71,370 women identified no benefit to maternal fetal movement counting. Women are now encouraged to tell their midwife or doctor if they feel a change in fetal movement as soon as possible, allowing for closer monitoring, which is why more accurate monitoring is needed.[14]. Other common methods for measuring fetal movement include ultrasound, MRI and cardiotocography. Ultrasonography, currently the gold standard for fetal movement detection, requires a skilled operator and is not suitable for long-term monitoring.[12] Advances in sensor technology can be used for long-term fetal movement recording [15.] Prominent fetal monitoring technologies include those based on acoustic sensors, accelerometers, and piezoelectric diaphragms [16]. Several studies have proposed approaches for long-term fetal movement recording using accelerometers [17 18 19. 20]. The results of the study showed that the use of accelerometers can provide useful information about fetal movement patterns. [21]. The use of two types of accelerometers can provide accurate measurements, but one type has greater advantages in terms of comfort for pregnant women. [16 .] The development of a fetal movement monitoring device using a 3D accelerometer showed that the device can provide accurate information about fetal movement and is reliable in different situations. [22.] The development of technology utilizing sensors to record bioelectricity is a challenge in the transformation of health in the field of biotechnology that can be used to detect fetal movement with a non-transmission and inexpensive system. For example, the use of a single accelerometer to record fetal movement averaged 62% better than that of ultrasound scanning using multiple ultrasound scans. [17.] Presented a fetal activity monitor that uses three accelerometers to detect fetal activity and an additional accelerometer, placed on the mother's chest, to detect artifacts from maternal activity.

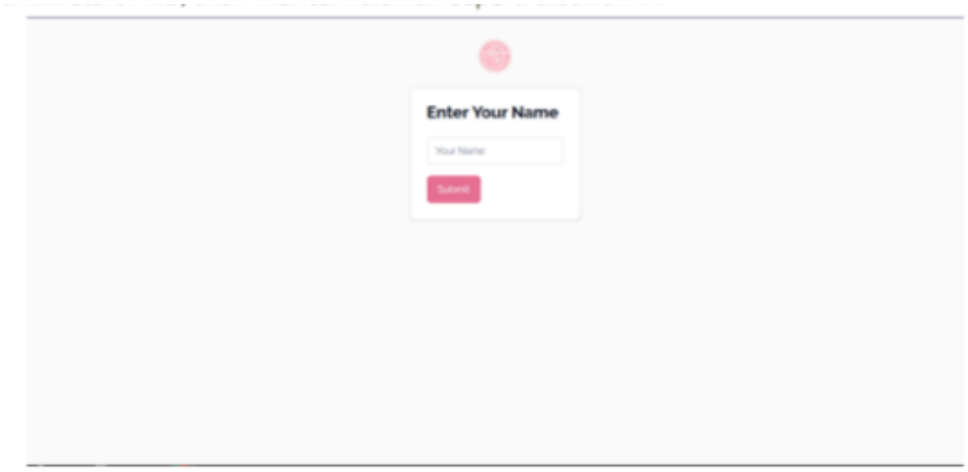
METHODS

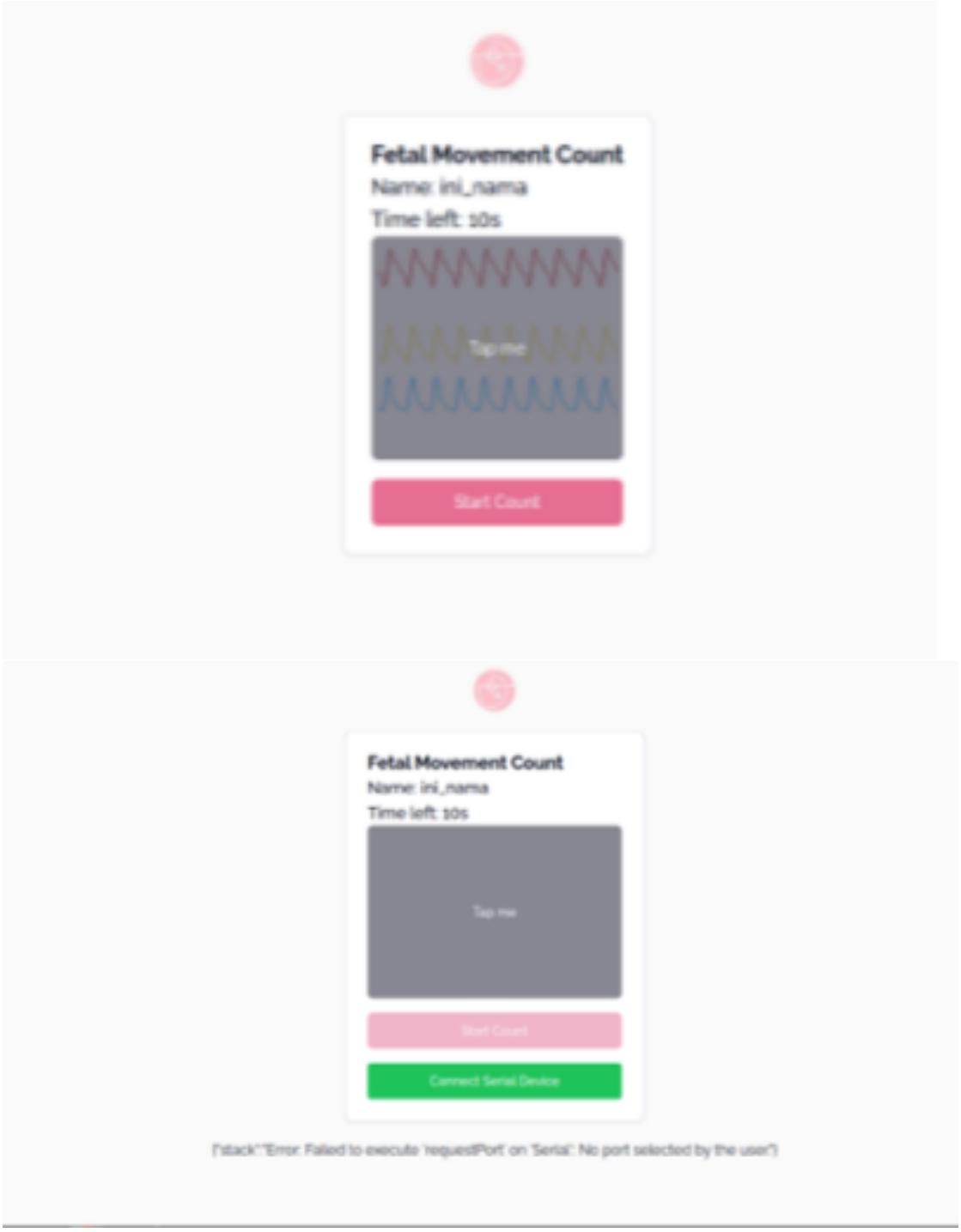
The research method used is the research and development (R&D) method, this method is used to develop certain products and test the effectiveness of the product.

RESULT AND DISCUSSION

The prototype is synchronized with the website using Bluetooth with the following display on the website :


Buka alamat fmd-app-fmd.vercel.app
fmd-app-fmd.vercel.app
Fetal Movement Detector
START FMD


Enter Your Name
Your Name
Submit


Fetal Movement Count
Name: ini_nama
Time left: 10s
Tap me
Start Count
Fetal Movement Count
Name: ini_nama
Time left: 10s
Tap me
Start Count
Connect Serial Device
{"stack":"Error: Failed to execute 'requestPort' on 'Serial': No port selected by the user'}

The display on the real-time website of fetal movement from the mother's perception can be displayed. The results displayed in the software are in the form of excel which will be processed into a logarithm of fetal movement recorded by the electrode and then an analysis of fetal movement signals will be carried out compared to the movement results from the mother's perception.
The data display in the software is as follows:

Figure 1: Fetal Movement Data

name: Via_Take_2	count: 2			
timestamp	channel1	channel2	channel3	tap
2024-08-22T02:05:1	6309576	6319603	6302817	0
2024-08-22T02:05:1	6309552	6319577	6302800	0
2024-08-22T02:05:1	6309543	6319572	6302806	0
2024-08-22T02:05:1	6309557	6319587	6302812	0
2024-08-22T02:05:1	6309554	6319587	6302813	0
2024-08-22T02:05:1	6309567	6319609	6302824	0
2024-08-22T02:05:1	6309575	6319611	6302831	0
2024-08-22T02:05:1	6309579	6319609	6302831	0
2024-08-22T02:05:1	6309597	6319631	6302844	0
2024-08-22T02:05:1	6309580	6319612	6302824	0
2024-08-22T02:05:1	6309566	6319598	6302815	0
2024-08-22T02:05:1	6309593	6319630	6302855	0
2024-08-22T02:05:1	6309621	6319649	6302867	0
2024-08-22T02:05:1	6309618	6319643	6302862	0
2024-08-22T02:05:1	6309608	6319626	6302851	0
2024-08-22T02:05:1	6309610	6319627	6302855	0
2024-08-22T02:05:1	6309599	6319614	6302841	0
2024-08-22T02:05:1	6309567	6319589	6302818	0

In the data above, bioelectric signals from fetal movements were recorded twice in 6 minutes.

Figure 2: Fetal Movement Data

name: Via_Take_1	count: 4			
timestamp	channel1	channel2	channel3	tap
2024-08-22T01:49:4	6311329	6322168	6307064	0
2024-08-22T01:49:4	6311334	6322175	6307071	0
2024-08-22T01:49:4	6311342	6322184	6307084	0
2024-08-22T01:49:4	6311349	6322181	6307081	0
2024-08-22T01:49:4	6311351	6322187	6307087	0
2024-08-22T01:49:4	6311349	6322192	6307101	0
2024-08-22T01:49:4	6311358	6322192	6307100	0
2024-08-22T01:49:4	6311357	6322205	6307099	0
2024-08-22T01:49:4	6311365	6322206	6307115	0
2024-08-22T01:49:4	6311392	6322232	6307144	0
2024-08-22T01:49:4	6311451	6322289	6307212	0
2024-08-22T01:49:4	6311472	6322294	6307205	0
2024-08-22T01:49:4	6311446	6322269	6307178	0
2024-08-22T01:49:4	6311423	6322246	6307161	0
2024-08-22T01:49:4	6311409	6322234	6307150	0
2024-08-22T01:49:4	6311411	6322239	6307159	0
2024-08-22T01:49:4	6311434	6322262	6307185	0
2024-08-22T01:49:4	6311452	6322273	6307189	0
2024-08-22T01:49:4	6311432	6322246	6307171	0
2024-08-22T01:49:4	6311432	6322258	6307180	0
2024-08-22T01:49:4	6311438	6322267	6307184	0
2024-08-22T01:49:4	6311435	6322262	6307176	0
2024-08-22T01:49:4	6311449	6322280	6307215	0
2024-08-22T01:49:4	6311539	6322375	6307309	0
2024-08-22T01:49:4	6311586	6322397	6307331	0
2024-08-22T01:49:4	6311578	6322393	6307320	0
2024-08-22T01:49:4	6311569	6322382	6307311	0
2024-08-22T01:49:4	6311546	6322365	6307290	0

In the data above, bioelectric signals from fetal movements were recorded 4 times in 6 minutes.

Figure 3: Fetal Movement Data

name: via	count: 7			
timestamp	channel1	channel2	channel3	tap
2024-08-23T10:46:2	6442654	6436393	6442250	0
2024-08-23T10:46:2	6442687	6436405	6442276	0
2024-08-23T10:46:2	6442682	6436403	6442250	0
2024-08-23T10:46:2	6442604	6436322	6442174	0
2024-08-23T10:46:2	6442540	6436292	6442139	0
2024-08-23T10:46:2	6442539	6436292	6442142	0
2024-08-23T10:46:2	6442546	6436303	6442141	0
2024-08-23T10:46:2	6442531	6436285	6442121	0
2024-08-23T10:46:2	6442510	6436264	6442119	0
2024-08-23T10:46:2	6442548	6436306	6442165	0
2024-08-23T10:46:2	6442585	6436340	6442206	0
2024-08-23T10:46:2	6442641	6436392	6442273	0
2024-08-23T10:46:2	6442704	6436445	6442322	0
2024-08-23T10:46:2	6442726	6436461	6442341	0
2024-08-23T10:46:2	6442732	6436470	6442345	0
2024-08-23T10:46:2	6442735	6436467	6442351	0
2024-08-23T10:46:2	6442778	6436510	6442396	0
2024-08-23T10:46:2	6442815	6436540	6442395	0
2024-08-23T10:46:2	6442747	6436460	6442315	0
2024-08-23T10:46:2	6442666	6436376	6442222	0
2024-08-23T10:46:2	6442609	6436338	6442187	0
2024-08-23T10:46:2	6442605	6436343	6442198	0
2024-08-23T10:46:2	6442609	6436340	6442192	0
2024-08-23T10:46:2	6442598	6436333	6442181	0
2024-08-23T10:46:2	6442621	6436363	6442226	0
2024-08-23T10:46:2	6442664	6436395	6442257	0

In the data above, bioelectric signals from fetal movements were recorded 7 times in 6 minutes.

Figure 4: Fetal Movement Data

name: via	count: 9			
timestamp	channel1	channel2	channel3	tap
2024-08-28T12:46:5	6421459	6413377	6409722	0
2024-08-28T12:46:5	6421500	6413415	6409760	0
2024-08-28T12:46:5	6421506	6413401	6409740	0
2024-08-28T12:46:5	6421489	6413387	6409728	0
2024-08-28T12:46:5	6421477	6413370	6409706	0
2024-08-28T12:46:5	6421451	6413348	6409679	0
2024-08-28T12:46:5	6421429	6413324	6409658	0
2024-08-28T12:46:5	6421408	6413308	6409644	0
2024-08-28T12:46:5	6421415	6413322	6409665	0
2024-08-28T12:46:5	6421439	6413342	6409683	0
2024-08-28T12:46:5	6421444	6413341	6409673	0
2024-08-28T12:46:5	6421443	6413340	6409675	0
2024-08-28T12:46:5	6421429	6413316	6409658	0
2024-08-28T12:46:5	6421420	6413307	6409651	0
2024-08-28T12:46:5	6421433	6413338	6409688	0
2024-08-28T12:46:5	6421481	6413380	6409732	0
24-08-28T12:46:5	6421502	6413393	6409729	0
2024-08-28T12:46:5	6421483	6413371	6409703	0
2024-08-28T12:46:5	6421447	6413334	6409663	0
2024-08-28T12:46:5	6421439	6413335	6409676	0
2024-08-28T12:46:5	6421463	6413359	6409703	0
2024-08-28T12:46:5	6421487	6413378	6409718	0
2024-08-28T12:46:5	6421484	6413373	6409709	0
2024-08-28T12:46:5	6421462	6413350	6409684	0
2024-08-28T12:46:5	6421437	6413331	6409668	0
2024-08-28T12:46:5	6421426	6413322	6409655	0
2024-08-28T12:46:5	6421418	6413321	6409652	0

In the data above, bioelectric signals from fetal movements were recorded 9 times in 6 minutes.
Figure 5: Fetal Movement Data

name: Via	count: 5			
timestamp	channel1	channel2	channel3	tap
2024-08-26T12:07:1	6396754	6399940	6403085	0
2024-08-26T12:07:1	6396770	6399941	6403089	0
2024-08-26T12:07:1	6396798	6399973	6403125	0
2024-08-26T12:07:1	6396851	6400017	6403178	0
2024-08-26T12:07:1	6396871	6400020	6403174	0
2024-08-26T12:07:1	6396851	6400008	6403159	0
2024-08-26T12:07:1	6396834	6399991	6403139	0
2024-08-26T12:07:1	6396803	6399953	6403109	0
2024-08-26T12:07:1	6396787	6399949	6403107	0
2024-08-26T12:07:1	6396802	6399974	6403133	0
2024-08-26T12:07:1	6396820	6399992	6403148	0
2024-08-26T12:07:1	6396827	6399996	6403138	0
2024-08-26T12:07:1	6396815	6399981	6403130	0
2024-08-26T12:07:1	6396804	6399970	6403114	0
2024-08-26T12:07:1	6396795	6399968	6403109	0
2024-08-26T12:07:1	6396782	6399949	6403088	0
2024-08-26T12:07:1	6396764	6399936	6403071	0
2024-08-26T12:07:1	6396770	6399949	6403099	0
2024-08-26T12:07:1	6396815	6399984	6403146	0
2024-08-26T12:07:1	6396858	6400024	6403178	0
2024-08-26T12:07:1	6396855	6400011	6403172	0
2024-08-26T12:07:1	6396851	6400015	6403168	0
2024-08-26T12:07:1	6396835	6399988	6403138	0
2024-08-26T12:07:1	6396781	6399937	6403090	0
2024-08-26T12:07:1	6396772	6399942	6403096	0
2024-08-26T12:07:1	6396778	6399957	6403099	0
2024-08-26T12:07:1	6396775	6399951	6403100	0

In the data above, bioelectric signals from fetal movements were recorded 5 times in 6 minutes.

Figure 6: Fetal Movement Data

name: Via	count: 10			
timestamp	channel1	channel2	channel3	tap
2024-08-26T12:15:0	6276490	6289463	6265591	0
2024-08-26T12:15:0	6276525	6289487	6265608	0
2024-08-26T12:15:0	6276499	6289453	6265574	0
2024-08-26T12:15:0	6276466	6289422	6265547	0
2024-08-26T12:15:0	6276461	6289437	6265566	0
2024-08-26T12:15:0	6276491	6289461	6265602	0
2024-08-26T12:15:0	6276543	6289515	6265656	0
2024-08-26T12:15:0	6276589	6289553	6265696	0
2024-08-26T12:15:0	6276607	6289568	6265709	0
2024-08-26T12:15:0	6276610	6289571	6265714	0
2024-08-26T12:15:0	6276626	6289582	6265726	0
2024-08-26T12:15:0	6276623	6289577	6265713	0
2024-08-26T12:15:0	6276598	6289553	6265694	0
2024-08-26T12:15:0	6276574	6289523	6265661	0
2024-08-26T12:15:0	6276538	6289500	6265633	0
2024-08-26T12:15:0	6276534	6289508	6265645	0
24-08-26T12:15:0	6276551	6289520	6265651	0
2024-08-26T12:15:0	6276547	6289513	6265647	0
2024-08-26T12:15:0	6276545	6289511	6265639	0
2024-08-26T12:15:0	6276520	6289490	6265619	0
2024-08-26T12:15:0	6276523	6289505	6265635	0
2024-08-26T12:15:0	6276556	6289529	6265654	0
2024-08-26T12:15:0	6276556	6289520	6265645	0
2024-08-26T12:15:0	6276550	6289512	6265648	0
2024-08-26T12:15:0	6276568	6289537	6265671	0
2024-08-26T12:15:0	6276582	6289542	6265674	0
2024-08-26T12:15:0	6276551	6289514	6265642	0
2024-08-26T12:15:0	6276532	6289494	6265628	0

In the data above, bioelectric signals from fetal movements were recorded 10 times in 6 minutes.
Figure 7: Fetal Movement Data

name: via	count: 11			
timestamp	channel1	channel2	channel3	tap
2024-08-28T12:38:4	6357024	6362926	6356488	0
2024-08-28T12:38:4	6357044	6362947	6356516	0
2024-08-28T12:38:4	6357075	6362979	6356548	0
2024-08-28T12:38:4	6357068	6362970	6356529	0
2024-08-28T12:38:4	6357040	6362940	6356503	0
2024-08-28T12:38:4	6357003	6362910	6356463	0
2024-08-28T12:38:4	6356988	6362904	6356456	0
2024-08-28T12:38:4	6356995	6362912	6356429	0
2024-08-28T12:38:4	6356931	6362841	6356336	0
2024-08-28T12:38:4	6356838	6362747	6356224	0
2024-08-28T12:38:4	6356767	6362682	6356154	0
2024-08-28T12:38:4	6356698	6362621	6355815	0
2024-08-28T12:38:4	6356101	6362026	6355214	0
2024-08-28T12:38:4	6355805	6361747	6354916	0
2024-08-28T12:38:4	6355753	6361690	6354858	0
2024-08-28T12:38:4	6355712	6361654	6354834	0
24-08-28T12:38:4	6355734	6361686	6354857	0
2024-08-28T12:38:4	6355737	6361686	6354859	0
2024-08-28T12:38:4	6355731	6361673	6354845	0
2024-08-28T12:38:4	6355721	6361675	6354840	0
2024-08-28T12:38:4	6355710	6361665	6354823	0
2024-08-28T12:38:4	6355690	6361643	6354794	0
2024-08-28T12:38:4	6355663	6361615	6354752	0
2024-08-28T12:38:4	6355616	6361572	6354683	0
2024-08-28T12:38:4	6355420	6361381	6354189	0
2024-08-28T12:38:4	6354531	6360495	6353296	0
2024-08-28T12:38:4	6354083	6360167	6352960	0
2024-08-28T12:38:4	6354044	6360141	6352929	0
2024-08-28T12:38:4	6354024	6360115	6352911	0
2024-08-28T12:38:4	6353999	6360092	6352880	0

In the data above, bioelectric signals from fetal movements were recorded 11 times in 6 minutes.

CONCLUSION

The prototype demonstrates superior noise reduction capabilities but may require optimized preprocessing to preserve event-related signal variations.

COMPETING INTERESTS

All authors had none to declare

AUTHOR'S CONTRIBUTION

Ida Widiawati conceived of the presented idea, data analysis, and writing manuscript; Muhammad Amrullah was in charge of data collection and analysis; Rika Resmana was drafting the manuscript. All authors contributed to the final manuscript.

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