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Smart Pregnancy Detection for Cow Using MATLAB

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---ABSTRACT---
Pregnancy testing in cattle are of two types i.e., invasive and non-invasive. Invasive methods includes manual rectal palpation of the reproductive tract that causes risks to theoperator and pregnancy, transrectal ultrasonography of the reproductive tract, etc. andnon-invasive methods includes enzyme-linked immunosorbent assay (ELISA), radioimmunoassay (RIA) or latex agglutination (LA) tests, etc. As, invasive methods are harmful to either pregnant cowor a person who is performing the test or both and the existing non-invasive methods are notpreferred as it has low specificity, sensitivity and also difficult to handle the sample.
Our main motto is to design a method which is non-invasive method which has better accuracy and can be operated by any unskilled person. Here, we present a simulation model of the design usingMATLAB. The pregnant state of the cow will be detected with less response time as soon as the data is fed into the code designed.
INDEX TERMS— ECG(Electrocardiogram), ELISA(enzyme-linked immunosorbent assay), HPF(High pass filter),K-means, latex agglutination (LA). LPF(low pass filter), Principle components, RIA(radioimmunoassay).

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I INTRODUCTION

P
REGNANCY
Detection is a standout amongst the most every now and again performed symptomatic strategies performed on cattle. During gestation, the observing of the heart rate is vital. The parameter extracted from the FECG i.e. fetal heart rate (FHR) can help the early location of pregnancy. The fundamental issue in fetal checking is the hard to remove the data from the fetus. Pregnancy test for cow has comprehensively two ways or types i.e., invasive and non-invasive. Rectal palpation of the reproductive tract and transrectal ultrasonography of the reproductive tract are the two most often utilized strategies for pregnancy identification of dairy cattle. These two strategies have a place with invasive type. The most established and most generally utilized system for pregnancy recognition in dairy cattle is the transrectal palpation of the uterus, which is by and by even today. The palpator must wear a defensive plastic sleeve that covers the arm and to the shoulder. The pregnancy location of dairy animals utilizing palpation takes just couple of moments. There are a few palpable structures that demonstrate pregnancy. Because of gathering of liquids inside the pregnant uterine horn, one of the signs of pregnancy is a qualification in size of uterine horns. Also, it is conceivable to feel the slipping of the fetal layer along the greatest curvature and flow inside the uterus. It has favorable position of being precise and modest, yet preparing is required for the operator. The primary disadvantage is this strategy can't be performed until later in gestation. This technique takes place between of 50 and 60 days after the insemination to expand the precision of the exam. By and by, ultrasound system is utilized for checking the fetal heart rate. The disadvantage of this

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technique is its sensitivity to improvement which can bring about moved reflected waves more grounded than the heart signal and furthermore will be unsafe to the fetus and even the cost and time taken for this strategy is more. Consequently ultrasound isn't utilized for long term checking of the FHR. This system is off base and it gives generally low positive value, it is solid just when the condition of the embryo is obviously great or awful. This technique takes in the vicinity of 55 and 75 days to recognize the pregnancy. Another technique to recognize the pregnancy in cow is milk progesterone test which is non-invasive. Progesterone is the hormone known as pregnancy hormone. This test is depends upon changes in the age of this hormone during reproductive cycles and pregnancy. Progesterone concentrations in milk or serum can be estimated utilizing a research center RIA (Radioimmunoassay) or ELISA (compound connected immunosorbent examine) methods. Pregnancy related glycoproteins are made by the placenta and trophoblast and it is immediate sign of pregnancy. These particles show up in the dissemination of pregnant cow from around 15 days after conception. This test however being non-invasive has numerous disadvantages like levels of PAG can happen after the parturition and furthermore result in false positive analysis in cows. The early rises of an event of levels of PAG available for use of dairy animals are tried inside seven days in the wake of encountering embryonic misfortune. As perfect pregnancy recognition test for dairy animals ought to have the accompanying highlights: high precision (sensitive and specific), non-invasive, simple and quick to anticipate the outcomes continuously, safe for bovine and the administrator, no different impacts or damage to pregnancy and ought to be simple for farmer to test it independent from anyone else. Keeping all the above highlights and downsides of other existing strategies we have thought of a strategy feasible. Here, we should utilize ECG signs to predict the pregnancy.

A non-invasive location of heart beat of the cow may permit improvement of continuous and early pregnancy identification. The fetus heart creates by 20-22 days and consistent beating by 30th day in embryogenesis. The depolarization of heart muscle tissue brings about age and spreading of electrical signal from the baby through the maternal tissue. Here, we should first get the real time signal from the dairy animals and we might process this signal utilizing MATLAB. Once the signal is gotten is prepared to required shape we should discover the peak to peak distance i.e., QRS tops which will yield us heart pulsates of the dairy animals. Once the heart beat esteem is gotten we might then contrast this heart beat and the range determined by us before in the information base and hence foresees whether the cow is pregnant or not.

II METHODOLOGY

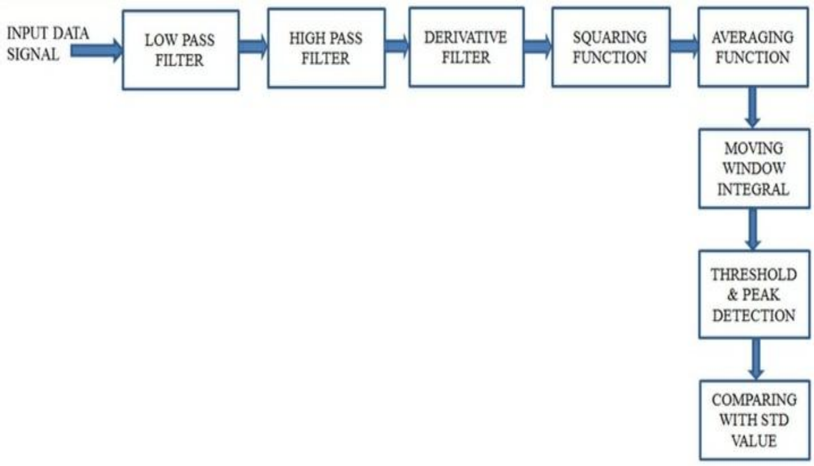


Fig 1: Proposed block diagram.

Here as in the fig.1, the ECG signals of cow is taken up as input raw data signal and given to low pass filter

A. **Low pass filter**

The transfer function of the second-order low-pass filter is

$(H(Z) = \frac{(1-z^{-6})^2}{(1-z^{-1})^2}$.

B. **High pass filter**

The design of the high-pass filter is based on subtracting the output of a first-order low-pass filter from an all-pass filter (i.e., the samples in the original signal). The transfer function for such a high-pass filter is

$(H(Z) = z^{-16} - [\frac{(1-z^{-32})}{(1-z^{-1})}]$

Here, the combination of LPF and HPF helps in reducing the false detection caused by various noises like muscle noise, noise due to electrode motion, power line interference, T wave interference.

C. **Derivative filter**

It discovers the adjustments in the slope of the signal. It demonstrates peak in the signal. In the wake of separating, the signal is separated to give the QRS complex slope data. We use a five-point derivative with the transfer function

H(z) = (l/8 T) ($-z^{-2}$ - $2z^{-1}$ + $2z^{1}$ + z^{2}).

The amplitude response is

|H(wT)| = (1/4T) [sin (2wT) + 2 sin (cwT)].

The difference equation is

y(nT) = (1/8 T) [-x(nT - 2 T) - 2x(nT - T) + 2x(nT + T) +x(nT+ 2T)].

D. **Squaring function**

It is used here to get the absolute values of the signal i.e., we are going to perform modulus operation. It also enhances the strength of the signal. Its equation is given as,

y(nT)=$[x(nt)]^2$.

E. **Averaging function**

We are going to perform the averaging function i.e., finding out the mean of the values.

F. **Moving window integral**

This operation is performed to find features of the waveform in addition to that of the slope. It is calculated from y(nT) = (1/N) [x(nT- (N - 1) T) +x(nT- (N-2)T)+…+x(nT)] where N is the quantity of tests in the width of the integration window. Here, moving window summation of previous N samples of output is done. N is based on sampling rate of the signal that is analyzed. It performs smoothening of output of the first activities through a moving window integration channel.

G. ***Threshold and peak detection***

Before performing threshold function, we cancel the delay created by LPF and HPF. In threshold function we first find the location of the peaks of QRS signal and then the thresholds are set such that it automatically adjusts itself and floats over the noise when passed through the filters. Finally, with the help of peaks we find the heartbeatof the cow.

H. ***Comparison with standard value***

Once the heartbeat of the cow is obtained, we try to compare that value with the range that is pre-defined and thus we can predict the pregnancy of the cow.

II. ALGORITHM

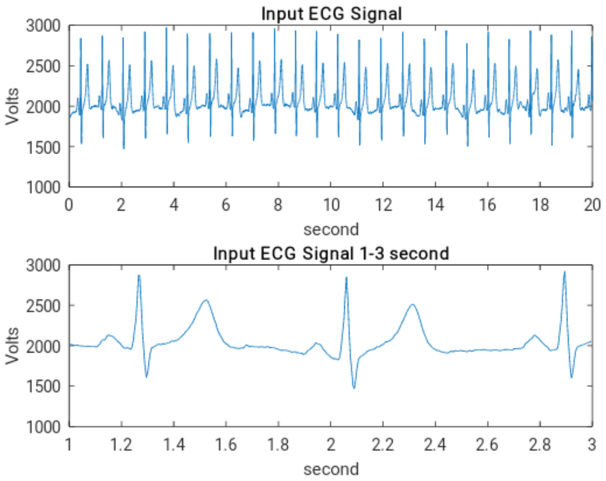
According to the block diagram in fig.1 and analyzing the requirements of the system, we have designed an algorithm for our simulation code which is as given below,

Step-1: Intake an ECG signal. i.e., the raw signal of the cow is taken as input.
Step-2: This signal is passed through the designed LPF and the output is recorded as below
Step-3: Convolute ECG values with the designed LPF
Step-4: Further and HPF is designed and the output is passed through it.
Step-5: Convolute ECG values with the designed HPF
Step-6: Take mean of the signal after passing it through LPF and HPF.
Step-7: Find out the QRS values using the locations of the signal
Step-8: Apply principle component analysis to find out the principle component.
Step-9: Cluster these principle components using k-means.
Step-10: Calculate the heartbeat using principle component after clustering.
Step-11: Based on the heartbeat obtained we are predicting the pregnancy of the cow.

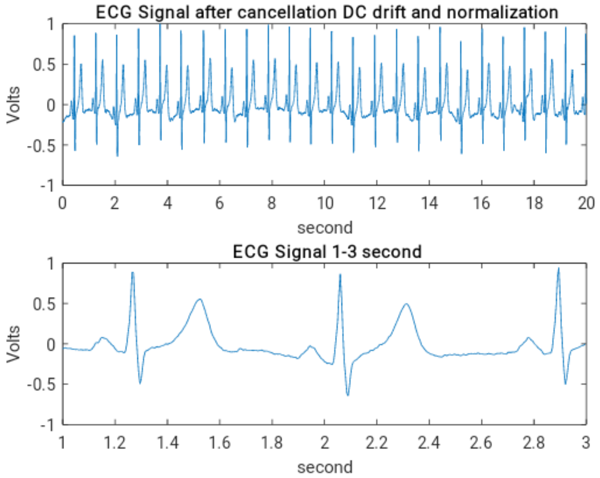
III RESULT ANALYSIS

According to the algorithm we have designed a MATLAB code and conducted a test with 4 ECG signal out of which two are pregnant and other two are non-pregnant ones. The screenshots of the output of each block in fig1., are as shown below,

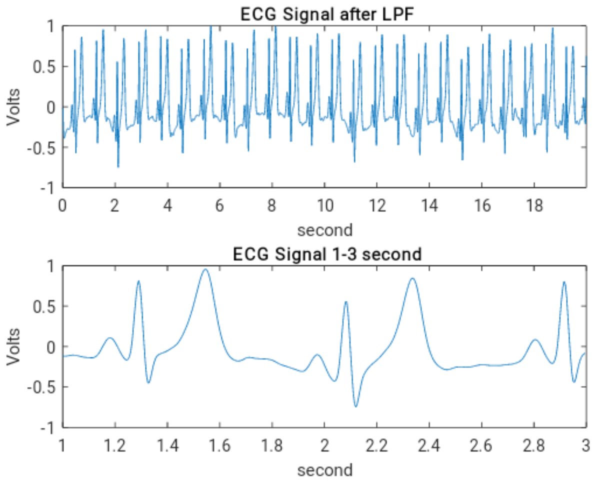
A. Input Data signal



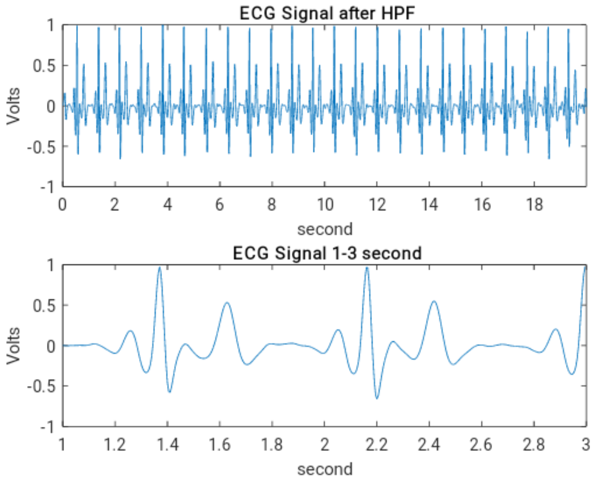
B. DC drift cancellation and normalization of ECG signal



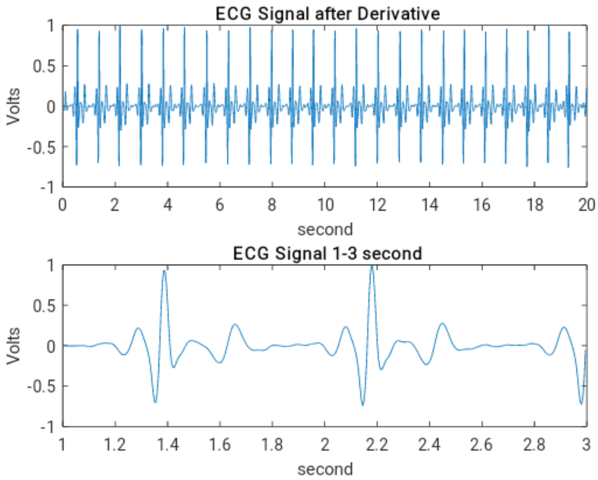
C. Output of LPF



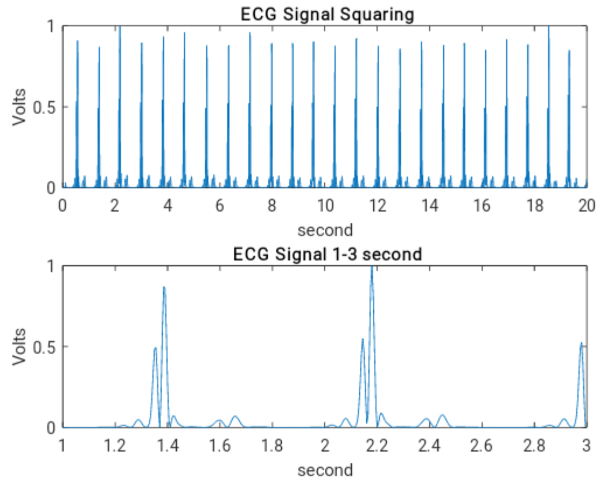
D. ***Output of HPF***



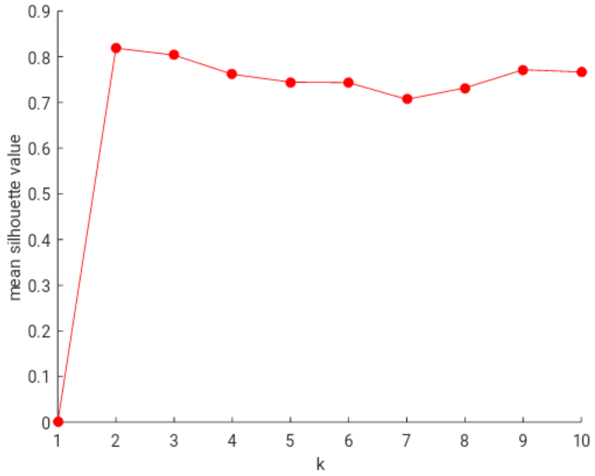
E. ***Derivate filter output***



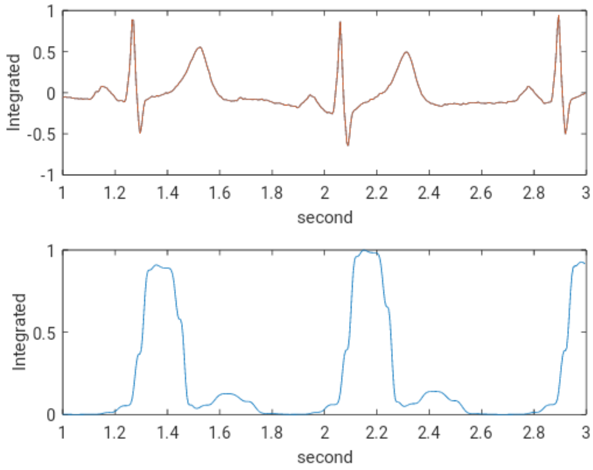
F. ***Squaring function***



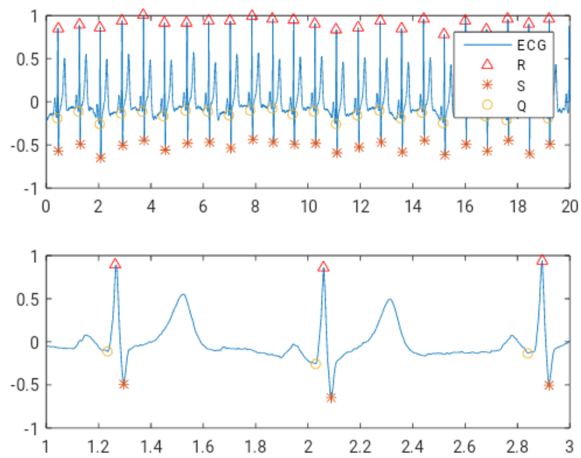
*G. **Averaging function output***



*H. **Moving window integral***

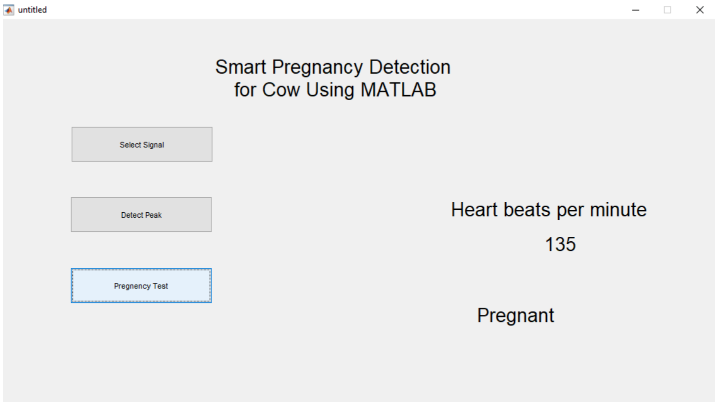


*I. **Threshold and peak detection***



*J. **Comparing with standard value and thus predicting the pregnancy of the cow.***

Here we compare the obtained heartbeat and if it is above 100 beats per minute we predict the cow to be pregnant and if heartbeat is below 100 beats per minute then it’s not pregnant.



Following table shows the outcomes of the test conducted by us,

SL No	Heart beats per Minute	Pregnant (P) or Not Pregnant (NP)
Cow A (ECG 1)	135	P
Cow B (ECG 2)	142	P
Cow C (ECG 3)	86	NP
Cow D (ECG 4)	93	NP

IV CONCLUSION

The results obtained using MATLAB for pregnancy detection of a cow is very fast and useful also this can be further enhanced by developing a prototype and predicting pregnancy on that device itself. As the algorithm designed by us has less response time and low latency the prediction is smooth and fast with good amount of accuracy involved.

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