SIMULATION IN MEMS OF THE STATUS OF SPECIFIC GRAVITY OF URINE AND ITS CORRELATION IN DATA MINING

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ABSTRACT

The status of specific gravity of urine in respect of parenchymal lesion involved in bacterial infection is of great medical importance for the treatment of the subject. The conclusion of the doctor is based on the accurate results in respect of the status of the specific gravity of urine. Mems is a effective and accurate tool for the measurement of the specific gravity of the liquid and thus the simulated results of the MEMS is of importance in respect to the diseases like nephropathy and parenchymal lesion. The trend of the diseases can be correlated with the simulated output for which classification is done in the data mining software DTREG for helping the physicians so that they can prescribe the treatment of the subject in a precise manner.

.**Key words:** *Simulation of MEMS, analysis of specific gravity of urine and renal diseases, data mining.*

1. Introduction

For the diagnosis of different diseases like nephropathy and parenchymal lesion involved in bacterial infection, it is required to measure the specific gravity of urine [1,2,3]. The existing method of measuring specific gravity of urine is time consuming, and involves possibility of human error. Thus we have introduced a new method to measure specific gravity of urine using MEMS. The phenomenon of cavity resonator is being used in our method. The concentration of solute in urine (specific gravity of the urine) can be measured by micro Electro Mechanical System (MEMS). For minimum specific gravity, the electrodes of MEMS will vibrate with maximum amplitude and thus the amplitude of the vibration of electrode is functionally related to specific gravity which is the underlying principle of MEMS for the measurement of specific gravity of urine in the context of this paper [4].

In density measurement methodology, the higher the weight of the fluid, lower the resonant frequency of the filled tube. The density or specific gravity sensor employs a chip level, vacuum packaged, and resonating silicon tube. While filled with a fluid, the tube is driven into resonance electrostatically and its motion sensed capacitively. Data obtained from the sensor is fed to software for further analysis of urine samples.

2. Existing System

The Existing system is a manual process which consumes weeks or months to test the urine from micro array expression data. In this system the diagnosis is based on various data like symptoms observations, laboratory data, bio statistic information, data base of the patient [5, 6, 7, 8]. The whole process is represented in the form of the block diagram as shown in fig 1.

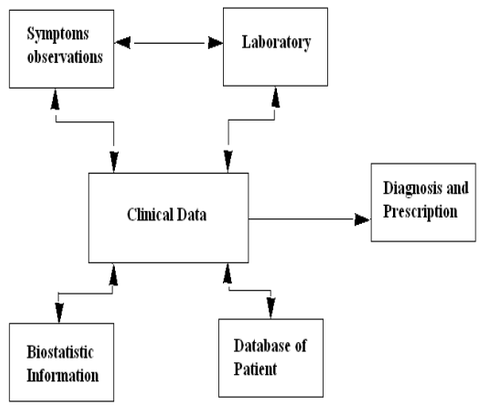

Fig.1 Existing system

Draw Backs of the Existing System:

1. Time consuming
2. Uncertainty in Decision Making
3. Possibility of human errors
4. Generates Bewildering amount of data

3. Proposed System

The proposed system is an automatic system which computes and takes decision automatically [9, 10]. Two sets of data have been made. One set of data has been used to train the system. After the system is trained then the system is tested with the other set of data. Later the system can take decision for any unknown data automatically. The block diagram of the system is shown in fig.(2).

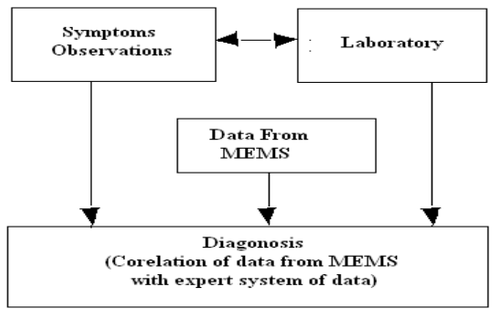

Fig 2: Proposed System

Advantages of Proposed system

1. Model produced high quality of output for urine test.
2. Produce reliable performance estimates.
3. Allow to apply models to unseen patients

3.1 MEMS

A capacitive sensor performs best with small gaps between electrodes. For micro machines, close spacing leads to squeeze film damping and molecular interaction during motion. For a resonant device, extensive damping results in low Q values (resonator quality factor) or poor signal-to-noise ratio. Vacuum packaging of the micro tube is employed to overcome this problem along with a compatible electrical lead transfer design. This has been accomplished using vacuum wafer-to-wafer bonding methods. From Mems measurement of specific gravity of urine was done by comparing its value with standard curve obtained in simulation of Mems [4].

3.2 Resonant Frequency Of Electrode Of Mems With Gain

For minimum specific gravity, the electrodes of MEMS will vibrate with maximum amplitude and thus the amplitude of the vibration of electrode is functionally related to specific gravity. Both these phenomena have been simulated by MATLAB 7.0 [11]. The sample closed loop transfer function of simulation of MEMS is as shown in Fig.3.Different curves of various resonant frequencies representing different urine samples have been simulated in MATLAB. The plot between gain and frequency is shown in Fig.4. Data obtained from MATLAB are decoded so that it can be fed to software for further analysis and correlation with the data of urine sample obtained from laboratory corresponding to the status of the subject.

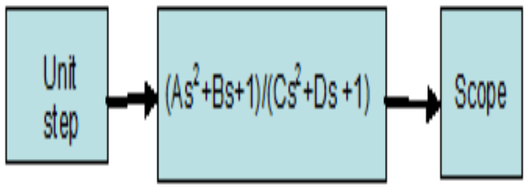

Fig.3 Sample closed loop transfer function of simulation of MEMS

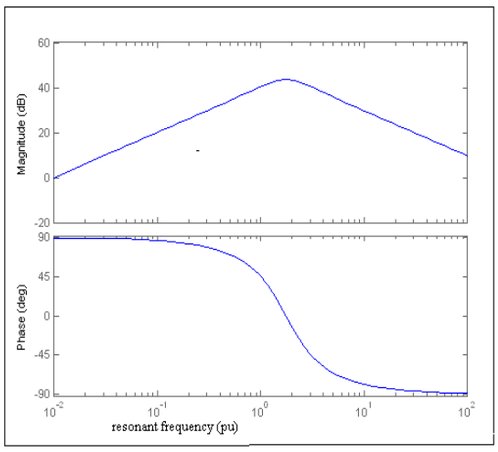

Fig.4 Relation of frequency Vs gain

3.3 Relation Of Specific Gravity Of Liquid And Output Voltage Of Mems

As the specific gravity of the liquid increases, the density of the liquid also increases and thus the mass of the liquid increases [12, 13]. With different specific gravity i.e different concentration of liquid the output voltage of Mems will vary according to the curve shown in fig 5.

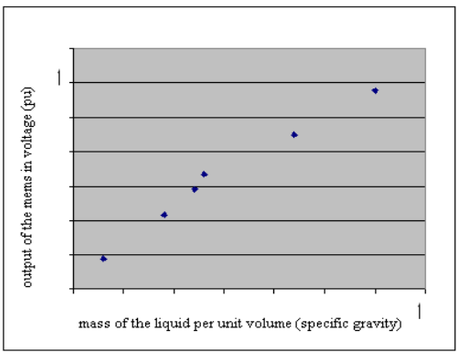

Fig 5. Relation of specific gravity of liquid and output voltage of Mems

1 per unit voltage = 1V
1 per unit specific gravity = 1.05gm/cc

3.4 Relation Of Frequency And Q Factor

Different curves of various resonant frequencies representing different urine samples have been simulated in MATLAB. A relation between frequency and Q factor=(Δf/ f) = (Δm/m) has been plotted after studying different curves where Δf is change of frequency corresponding 3db difference with max value corresponding to f . The relation obtained is as shown below in fig 6.

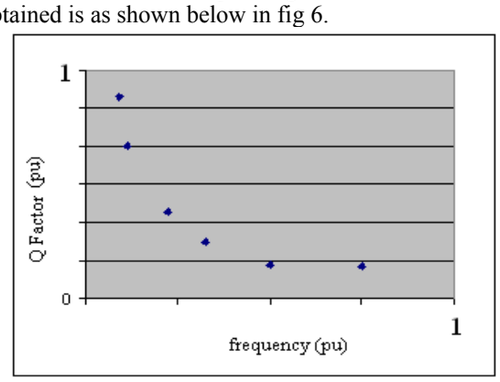

Fig 6. Relation of frequency and Q factor

1 per unit Q-factor = 10
1per unit frequency = 10 kHz

3.5 Relation Of Mass Of The Liquid And Resonant Frequency

The relation was obtained by studying the result from Matlab and is shown below in fig 7.

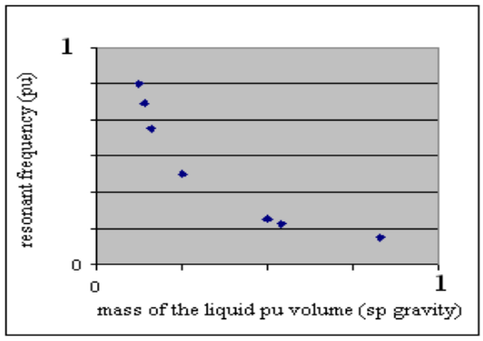

Fig.7. Relation of mass of the liquid and resonant frequency

1 per unit resonant frequency= 10 KHz
1 per unit specific gravity = 1.05 gm/cc

3.6 Matlab Simulation In Renal Disorder

The curves have been simulated in Matlab Simulink 7.0. In this we have simulated the curves related to specific gravity of the urine related to bacterial infection and this simulation is in agreement with the clinical values.

The silicon tube resonator can be represented by equivalent mechanical configuration shown in fig.8.

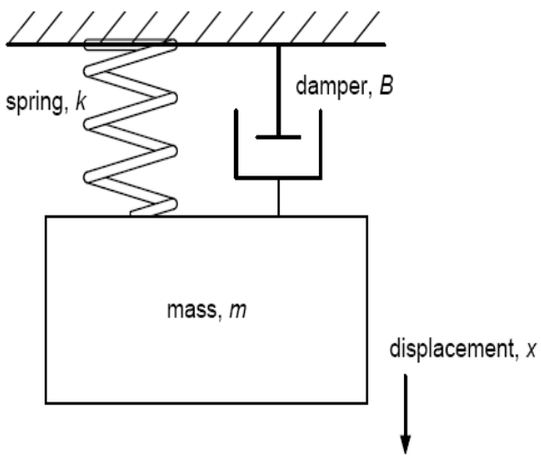

Fig.8 representation of silicon tube resonator

A typical block diagram involved in simulink 7.0 is shown below in fig 9

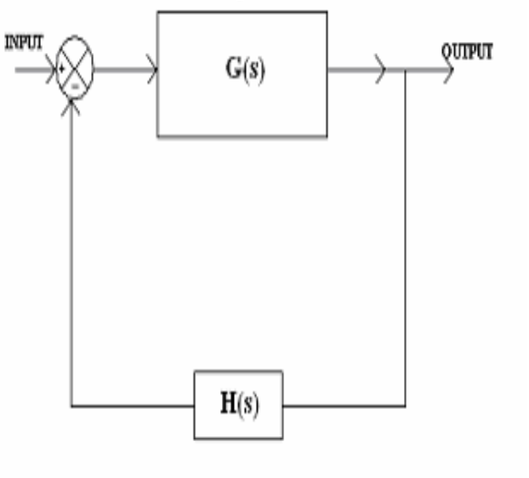

Fig 9. Block diagram in simulink 7.0

The transfer function of Matlab simulation is given by to equation below

$$G(s)\,H(s) = \frac{1}{m \cdot s^2 + B \cdot s + k}$$

The graph shows the different stages of status of bacterial infection with time. Specific gravity of urine if regularly checked is an important parameter in the diagnosis of diseases [9, 14, 15, 16]. We have simulated the curves in normalized way for projecting the status of the subject suffering from repeated bacterial infection [17-21]. There is a possibility of renal failure with repeated and very late bacterial infection as shown in Fig 10.

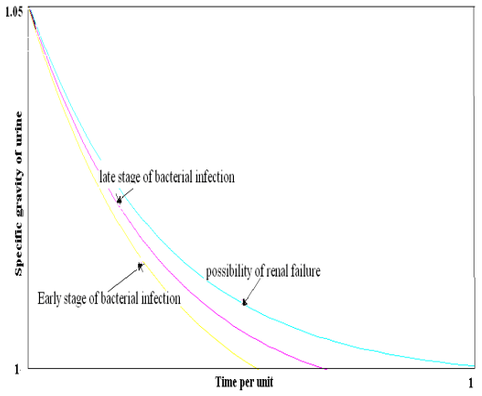

Fig.10 Stages of impact of bacterial infection with time

1 per unit time = 2 Years

4. Data Mining

Parenchymal lesion may be caused by repeated bacterial infection in urinary tract. The status of diseases associated with bacterial infection has been classified in data mining through the use of software DTREG [22, 23]. Data mining is a powerful statistical analysis program that generates classification and regression decision trees that model data and can be used to predict values. Data mining has been done by the software DTREG which is a robust application that is installed easily on any Windows system. DTREG reads Comma Separated Value (CSV) data files that are easily created from almost any data source. Through DTREG the classification of trees has been done through a particular option (single tree mode) present in the software where the target variable being predicted is categorical and Regression [24].

5. Result

The results of data mining associated in repeated bacterial infection in the context of the status of the kidney has been done and the results indicate that there is possibility of renal failure for repeated late bacterial infection when the specific gravity is greater than 1.029. When the specific gravity is less than 1.029 and approaching towards 1 then there is no possibility of renal failure. Table 1 shows the status of the subject with duration of infection linked with specific gravity of urine.

Table 1: Status of various diseases in Data mining

Time (Month)	Specific Gravity	Diseases	Mis classification
<=17.2	>1.009	Late BI*	60.76%
<=17.2	<=1.009	Late BI*	30.77%
<=11.6	<=1.009	Early BI*	0%
>11.6	<=1.009	Late BI*	0%
<=17.2	>1.009	Renal Failure	53.03%
<=13.6	>1.009	Renal Failure	61.4%
>13.6	>1.009	Renal Failure	0%
<= 10	>1.009	Late BI*	66.67%
>10	>1.009	Late BI*	50%
<= 10	<=1.03	Early BI*	27.27%
<= 10	>1.03	Renal Failure	53.57%
>10	<=1.029	Late BI*	30.77%
>10	>>1.029	Renal Failure	0%

*** BI- Bacterial Infection**

6. Conclusion

The status of kidney with repeated bacterial infection has a great impact on the physiological condition of the subject. In this respect the status of kidney of the subject should be of great concern related to repeated bacterial infection.

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