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RANCANG BANGUN ARSITECTURE PENGINDERAAN KOMPRESIF UNTUK AKUISISI DATA TEKANAN DARAH MENGGUNAKAN METODE REKONTRUKSI OMP

COMPRESSIVE SENSING ARCHITECTURE DESIGN FOR BLOOD PRESSURE DATA ACQUISITION USING OMP RECONSTRUCTION METHOD

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Abstract
In the current era of digitalization, there are so many applications of digital devices for daily necessities even for medical demand as well. One of them is the use of a digital blood pressure device which has advantages such as being easy to read and understand, small, easy to carry everywhere and relatively cheap in price. However, the problem is how accurate the device is when compared to analog/conventional devices whose accuracy has so far been no doubt. The Goal of this this design is knowing the accuracy of the measurement instrument, in this case as blood measurements instrument using the OMP and evaluation metric with data sampling size respectively K 128, K 64 K 32 and K 16, for assessing which data size having better accuracy.

Keywords : Digital blood pressure, orthogonal matching pursuit (OMP), gaussian transform, wavelet transform, evaluation metrics.

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1. Background

Analyzing the accuracy of a digital portable blood pressure instrument is crucial for several important reasons, as accuracy directly impacts the reliability and usability of the device. Here are several key reasons why accuracy assessment is essential such as patient safety, clinical decision making, disease management, public health surveillance, home monitoring and self-management, research and clinical trial, regulatory compliance, patient trust and compliance, technology improvement and health cost efficiency.

While digital blood pressure devices offer numerous advantages, they also have certain weaknesses and limitations. It's essential to be aware of these factors to ensure accurate and reliable blood pressure measurements. Here are some weaknesses associated with digital blood pressure devices such as accuracy in specific populations, calibration and maintenance, user technique, battery dependency, electronic interference, quality variability, etc.

In this research, we propose using a raspy device as minicomputer as interface device for processing and storing blood data from a digital blood pressure device. The MySQL and Jupiter program will install in Raspberry Pi 4B+ device for processing the inputs data using Gaussian Transform or Wavelet Transform and OMP method, then will analyze with evaluation metric.

1.1 Problem Formulation

The Problems for analysis such as:

1. How to make sure that a blood pressure device used has high accuracy in measuring blood pressure for vital patient safety reasons because inaccurate readings could lead to incorrect diagnosis, inappropriate treatment decisions, and potential harm to patients.
2. How to increase the accuracy of a digital blood pressure device?
3. What is the effect of increasing data size on the accuracy of a digital blood pressure device?

1.2 Objectives and Benefits

The Goal this project is to develop the digital blood pressure device measuring patient blood pressure which allow to be monitored remotely by the medical experts such as doctor or nurse using internet as the web base even though different location of them.

Objective of this research:

1. Design of compressive sensing architecture to obtain blood pressure data using sparse binary estimation matric and OMP reconstruction method.
2. The Design comes with built-in memory and data storage capabilities, that allows for the recording and tracking of multiple measurements over time, facilitating better monitoring of blood pressure trends.
3. The Design of architecture can be designed to integrate with electronic health record systems, facilitating seamless data transfer between healthcare providers and ensuring a more comprehensive patient health history.

1.3 Research Methods

Methods of Observation as following:

1. Theoretical Study/Literature Study
2. Empirical Measurement
3. Simulation
4. Design

2. Basic Theory

Internet of Medical Things

Internet of Medical Things (IoMT) is the application of IoT to collect and analyze data for medical and health related purposes, research, and monitoring. In addition, the use of mobile devices to aid in medical monitoring has led to the creation of "m-health", which uses analyzed health statistics.

Blood Pressure

Blood pressure is one of the key markers that medical professionals use to assess a patient's health, along with respiratory rate, heart rate, oxygen saturation, and body temperature. Traditionally, healthcare practitioners measure blood pressure non-invasively with an aneroid or mercury-tube sphygmomanometer by listening to (listening) the arteries in the arm with a stethoscope while the arteries are in closer to the heart. However, semi-automated methods have become popular, largely due to concerns about potential mercury toxicity, despite cost, ease of use, and applicability for acute blood pressure measurements. study or at home also influenced this trend.

2.1 Equation of MSE, MAE, PRD, SNR

Mean Squared Error Equation: (1)

$$MSE = \frac{1}{n}\sum_{i=1}^{n}(Xi - Yi)^2$$

Mean Absolute Error Equation: (2)

$$MAE = \frac{1}{n}\sum_{i=1}^{n}|Xi - Yi|$$

Peak Relative Difference Equation: (3)

$$PRD = \frac{\sqrt{\sum_{i=1}^{n}(Xi-Yi)}}{\sqrt{\sum_{i=1}^{n}Xi2}}$$

Signal to Noise Ratio Equation: (4)

$$SNR = 10\ log_{10}\frac{\sum_{i=1}^{n}Xi2}{\sum_{i=1}^{n}(Xi-Yi)2}$$

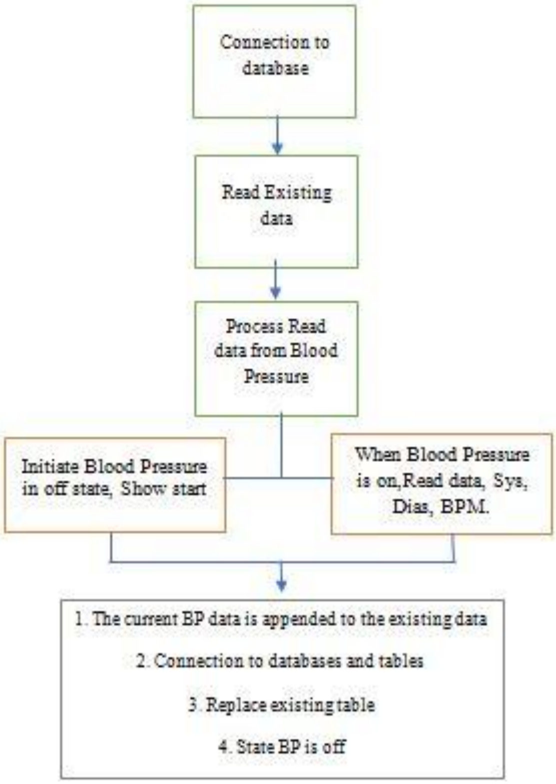
2.2 OMP (*Orthogonal Matching Pursuit*)

The main difference with MP is that after each step, all coefficients extracted so far are updated by computing the orthogonal projection of the signal on the subspace covered by the group of atoms chosen for now. OMP has been shown to provide stability and performance under certain limited isostatic conditions. Released three years before MP, the Incremental Multi-parameter Algorithm (IMP) works similarly to OMP. Matching Pursuit is related to the field of compression detection and has been extended by researchers in this community. Notable extensions include Orthogonal Match Pursuit (OMP), Staged OMP (StOMP), Compression Sampling Match Pursuit (CoSaMP), Generalized OMP (gOMP), and Object Pursuit. multipath comparison (MMP).

2.3 Table Parameter Evaluation Metrics and Flow Chart Blood Pressure

Table 1. Result of MSE, PRD, SNR, MAE, MAE(%)

SAMPLING SIZE	SYSTOLIC					DIASTOLIC					BPM				
	MSE	PRD	SNR (dB)	MAE	MAE (%)	MSE	PRD	SNR (dB)	MAE	MAE (%)	MSE	PRD	SNR (dB)	MAE	MAE (%)
K 128	6.070,56	0,60	4,45	64,01	38,55	2.096,16	0,59	4,55	37,40	27,01	2.010,96	0,61	4,33	37,05	40,70
K 64	9.828,27	0,76	2,35	90,32	47,35	3.503,00	0,77	2,31	53,84	32,79	3.204,01	0,77	2,30	51,07	49,14
K 32	11.762,41	0,83	1,58	102,76	54,36	4.205,74	0,84	1,52	61,20	38,07	3.793,85	0,83	1,58	58,13	55,17
K16	14.118,97	0,91	0,78	116,45	62,25	5.023,65	0,92	0,75	69,08	43,05	4.576,06	0,92	0,75	65,93	64,22



Picture 1. Flowchart Blood Pressure

3. Discussion

Result of MSE, PRD, SNR, MAE, MAE(%)

Mean Square Error (MSE) is a metric used to measure the average squared difference between recovered values and actual (observed) values. Based on our processing data, Table 4.1 shows that Mean Squared Error (MSE) values for recovered signals in the context of blood parameters (systolic, diastolic, and BPM) based on different sample sizes (K 128, K 64, K 32, and K 16).

Generally, as the sample size (K) decreases, the MSE values tend to increase. This implies that the accuracy of the recovered signals is lower for smaller sample sizes. A lower MSE indicates better accuracy, meaning that the recovered signals are closer to the true values. Therefore, K 128 has the lowest MSE values among the sample sizes provided. The lower MSE values generally suggest better performance of a blood pressure device, in consequence that we need to take more data size.

Flowchart of Blood Pressure

The design flow of this system is described in the flowchart. The flowchart explains what plays a role in the process of using Blood Pressure sensor.

OMP be indirectly related to blood pressure measurement

1. Blood Pressure Signal: Blood pressure measurements can be recorded as a continuous waveform. In some cases, researchers may want to analyze this signal to extract meaningful features or detect specific patterns.
2. Sparse Representation: The blood pressure signal may contain redundant or irrelevant information. Using OMP, one could attempt to represent the blood pressure signal as a combination of a few relevant basis functions that capture the essential features of interest, potentially reducing the amount of data needed for further analysis.
3. Signal Analysis: Once the sparse representation is obtained using OMP, researchers could use the selected basis functions to perform various analyses, such as detecting specific blood pressure patterns, identifying anomalies, or predicting future blood pressure values.

4. Conclusion

Analysis, prototyping and testing of the compressive sensing architecture design to obtain blood pressure data using the OMP reconstruction method,

1. In this analysis, we use the fast Fourier transform (FFT) for recovered signal
2. The data Shows that the sensing architecture can obtain, store and reconstruct blood pressure data using the OMP reconstruction method.
3. In data of Systolic, Diastolic, Bpm Compressive sensing in that process can conclude result of sample affect the error.
4. The data recovered by each value of K, namely K=128, K=64, K=32, K=16, has a different test and variable error rate under sample conditions. K=16 has a high error rate compared to K=128, K=64, K=32. This proves that signals that are recovered when data damage occurs can be recovered, but the recovered signals have different results.

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Lampiran

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