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Analysis on the accuracy of a decision support system for hypertension monitoring

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Introduction

Hypertension is a 'silent killer' since it could lead to complications, such as heart attacks, strokes, and kidney failures without any symptom. Motivated by helping people reduce the risk of hypertension, we design a decision support system for hypertension monitoring. This system can automatically collect patient's data and make some decisions on the status of a hypertension patient. Once some emergent cases occur, some messages on patient status and related medical data would be sent to some clinicians or doctors via advanced telecommunication and internet technologies. In this case, patients can stay at home or at office to get regular checks of their blood pressure.

Architecture of our hypertension monitoring system

Our decision support system (We call it WeHealth system) for hypertension monitoring is designed to make decisions on the status of patients and deliver hypertension-related services and information via telecommunications and computing technologies. In our WeHealth system, blood Pressure (BP) data of a particular patient are gathered by a BP measurement device and then transferred to a data server in hospital via wireless networks and internet. Building on these arriving BP data, a decision support unit in the data server would make some initial decisions on patient conditions. By referring to these initial decisions, doctors would make the final decisions on patient condition

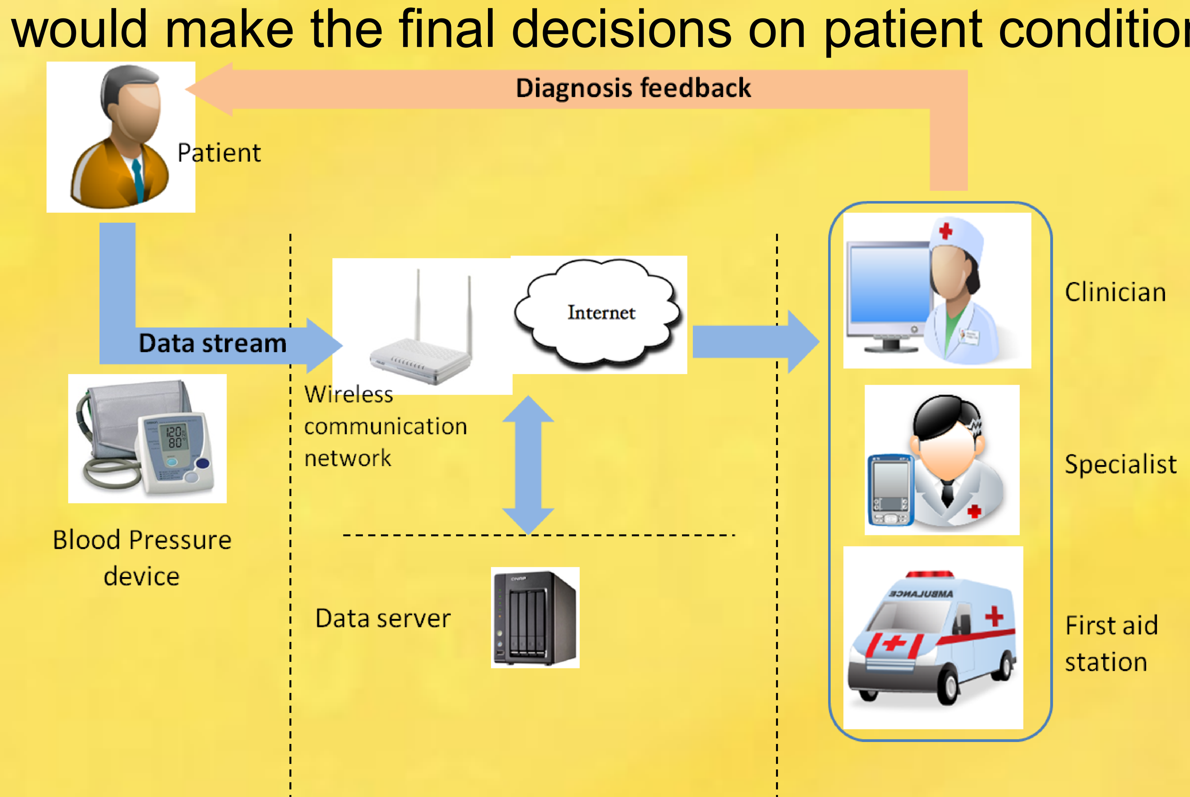

Fig.1 Architecture of the decision support system for hypertension monitoring

and send their diagnosis to patients through a reverse link, denoted as diagnosis feedback in Fig.1. In our system, a decision on patient status is made based on a standard in medicine for the risk stratification of hypertension, shown in Table I. In Table I, stage 1, stage 2 and stage 3 represent different types of hypertension, and this classification is based on the values of systolic pressure and diastolic pressure, shown in Table II.

	Risk factors and history of hypertension	Blood pressure		
		Stage1	Stage2	Stage3
Case1	No risk factors	Low risk	Moderate risk	High risk
Case2	One or two risk factors	Moderate risk	Moderate risk	Extremely High risk
Case3	More than three risk factors	High risk	High risk	Extremely High risk
Case4	Complications	Extremely High risk	Extremely High risk	Extremely High risk

Table I Standard for the risk stratification of hypertension

Classification	Systolic pressure (mmHg)	Diastolic pressure (mmHg)
Normal or Prehypertension	<139	<89
Hypertension (Stage1)	140-159	90-99
Hypertension (Stage2)	160-179	100-109
Hypertension (Stage3)	>179	>109

Table II Classification of hypertension

Analysis on the system accuracy

In our system, making a decision depends on both the blood pressure data gathered by medical sensors and some contexts manually entered by clinicians. To estimate the system accuracy, we take into account both the sensors' errors as well as the errors caused by the manual entry of contexts.

In the traditional method, the estimation of system accuracy only depends on whether the decisions on patient status are correct. It cannot differentiate whether the decision is made in a correct context or in an incorrect context, since an incorrect entered context may also lead to a correct decision. For instance, when the medical data is in stage 1, both the exact context (we say case 1) and the entered context (we say case 2) can reach the same decision *M*. While the decision on patient status is correct, the system can provide little information to doctors and even mislead doctors if the decision is made in an incorrect

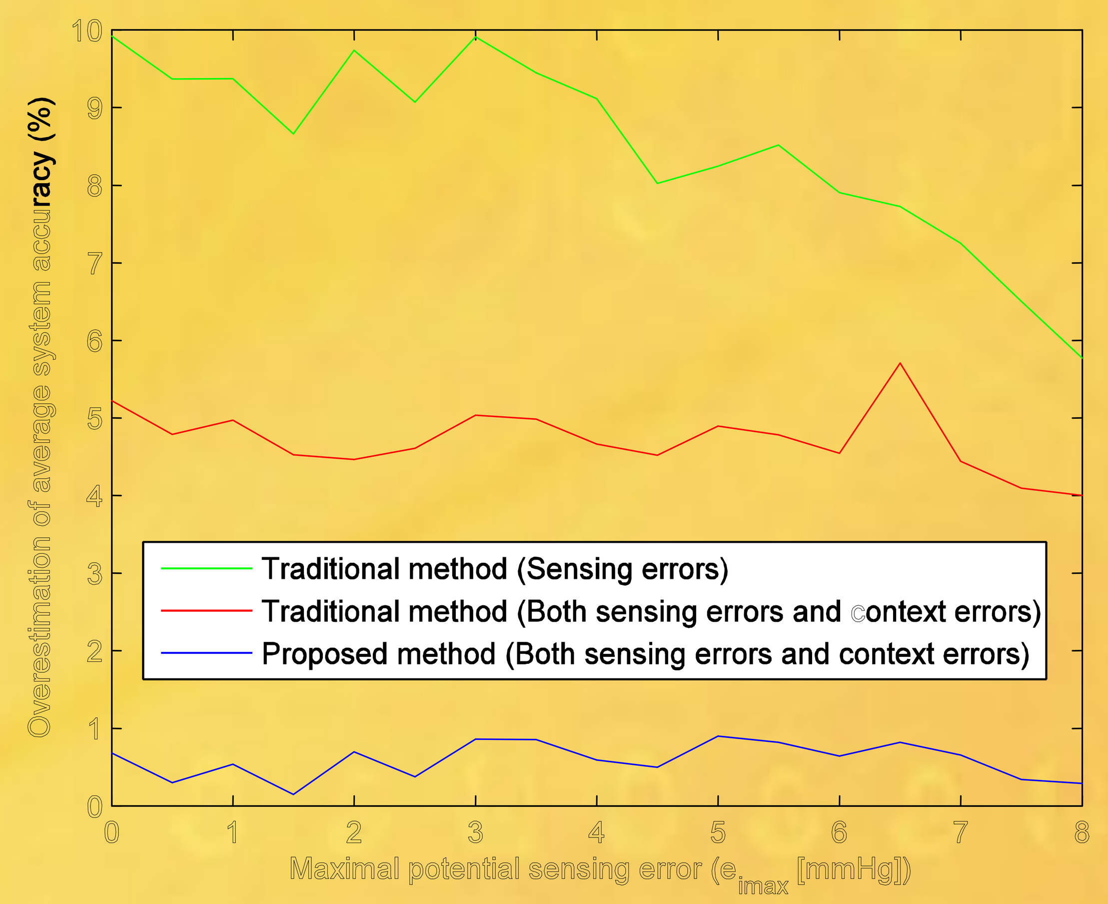

Fig.2 Gap between the theoretical result and the simulation result

context, since doctors may take different actions to the patient in different contexts. Due to the limit of the traditional method, we propose a novel method to estimate system accuracy by modifying the traditional estimation method. In the proposed method, the evaluation of system accuracy depends on not only the decisions on patient status but the contexts in which these decisions are made. In comparison with the simulation result by our system, the gap across several theoretical results is shown in Fig.2.

Conclusion

In this paper, building on a standard in medicine, we design a decision support system for hypertension monitoring. Additionally, we propose a theoretical method to evaluate the accuracy of our hypertension monitoring system by linking the system accuracy with the distribution of sensors' errors and the errors of context entry. To show the reliability of our method, we demonstrate the validity of all three assumptions of our method, either by citing reference or by taking measurement. To show the efficiency of our method, we compare the system accuracy estimated by our method and that by the traditional method. The result shows that our proposed method can well estimate the system accuracy.