

RANCANG BANGUN SISTEM PEMANTAU PARAMETER KUALITAS TIDUR OBJEKTIF BERBASIS *PHOTOPLETHYSMOGRAPHY* PADA JARI TANGAN

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INTISARI

Tidur adalah keadaan istirahat alami ditandai penurunan kesadaran, aktivitas otot, dan laju metabolisme, terbagi menjadi 2 fase : *Non-Rapid Eye Movement* (NREM) dan *Rapid Eye Movement* (REM). Fase NREM ditandai berkurangnya aktivitas saraf dan detak jantung, sedangkan fase REM ditandai meningkatnya aktivitas otak seperti saat bangun. Parameter kualitas tidur objektif dilihat dari efisiensi tidur, serta persentase durasi fase bangun, NREM, dan REM. Metode standar yang biasa digunakan adalah *polysomnography* (PSG) dengan alat ukur utamanya *electroencephalograph* (EEG) yang valid dan presisi tinggi dengan mengukur gelombang otak, namun metode tersebut tidak praktis, mahal, dan butuh tenaga ahli. Sehingga diusulkan metode alternatif yaitu *photoplethysmography* pada jari tangan.

Untuk menyelesaikan masalah tersebut dilakukan metode penelitian eksperimental dan validasi dengan EEG dengan data pengujian 10 responden. Sistem pemantau parameter kualitas tidur objektif berbasis *photoplethysmography* (PPG) pada jari tangan yang valid dan presisi berhasil dirancang bangun dengan perangkat keras berupa sensor *pulse heart rate* berbasis LED hijau dan fotodiode mode reflektif, di mana sinyal yang dihasilkan dikonversi menjadi sinyal digital dan diakuisisi oleh mikroprosesor, kemudian diproses oleh perangkat lunak di *personal computer* yang dilengkapi dengan algoritma ekstraksi fitur, estimasi dengan deteksi puncak, dan fusi dengan penghalusan temporal untuk menghitung laju pernapasan dan variabilitasnya sebagai dasar perhitungan parameter kualitas tidur objektif, dengan hasil analisis : nilai pengulangan/*repeatability* fase bangun = 2,42% ; NREM = 2,09% ; REM = 0,99% ; efisiensi tidur = 2,42% ; nilai reproduktibilitas/*reproducibility* fase bangun = 2,13% ; NREM = 2,16% ; REM = 1,69% ; efisiensi tidur = 2,13% ; dan nilai bias fase bangun = 3,07% dengan LoA 8,31% dan -2,18% ; NREM = -1,25% dengan LoA 5,95% dan -8,45% ; REM = -1,82% dengan LoA 1,71% dan -5,35% ; efisiensi tidur = -3,07% dengan LoA 2,18% dan -8,33% .

Kata kunci: *Tidur, Kualitas Tidur, Photoplethysmography, Jari Tangan*

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DESIGN AND DEVELOPMENT OF OBJECTIVE SLEEP QUALITY PARAMETER MONITORING SYSTEM BASED ON FINGER PHOTOPLETHYSMOGRAPHY

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ABSTRACT

Sleep is a natural resting state characterized by decreased consciousness, muscle activity, and metabolic rate, divided into two phases: Non-Rapid Eye Movement (NREM) and Rapid Eye Movement (REM). The NREM phase is marked by reduced neural activity and heart rate, while the REM phase shows increased brain activity similar to wakefulness. Objective sleep quality parameters can be assessed based on sleep efficiency and the percentage duration of wake, NREM, and REM phases. The standard method typically used is polysomnography (PSG), with the main device being electroencephalography (EEG), which is highly precise and valid in measuring brain waves however, this method is impractical, expensive, and requires a sleep expert. Therefore, an alternative method using photoplethysmography on the fingertip is proposed.

To address this issue, an experimental research method was conducted and validated using EEG data from 10 respondents. A valid and precise objective sleep quality parameter monitoring system based on fingertip photoplethysmography was successfully designed, utilizing hardware that consists of a green LED pulse heart rate sensor and a reflective photodiode. The generated signals were converted into digital signals and acquired by a microprocessor, then processed by software on a personal computer equipped with feature extraction algorithms, peak detection estimation, and temporal smoothing fusion to calculate respiratory rate and its variability as a basis for objective sleep quality parameter calculations. The analysis results showed the repeatability value of the wake phase = 2.42%; NREM = 2.09%; REM = 0.99%; sleep efficiency = 2.42%; the standard deviation for reproducibility of the wake phase = 3.86%; NREM = 2.16%; REM = 1.69%; sleep efficiency = 2.13%; and the wake phase bias value is 3.07% with LoA of 8.31% and -2.18%; NREM is -1.25% with LoA of 5.95% and -8.45%; REM is -1.82% with LoA of 1.71% and -5.35%; sleep efficiency is -3.07% with LoA of 2.18% and -8.33%.

Keywords: *Sleep, Sleep Quality, Photoplethysmography, Finger*

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