

Development of Low Cost IoT Based Health Monitoring System

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Abstract:

One key idea here shifts how we watch health - using internet-connected tools to track heartbeat and blood oxygen live. Built around a small computer called ESP32, this setup links up with a MAX30102 device that grabs body signals nonstop. Instead of just storing numbers, the machine reads them on the spot, then beams details over wireless networks for outside review. What shows up right away appears on a tiny screen attached directly to the unit - no waiting needed. When something looks off, alerts go out automatically, so people who care can respond fast. Remote check-ins become possible not only for medical staff but also loved ones keeping tabs from afar. A small gadget like this moves easily between places, works without draining power, plus it runs cheap enough for long-term use at medical centers or inside homes. Built on internet-connected tech, such tools open doors to better care access while cutting down hands-on checks - also they feed into smarter health networks that operate with less waste

Keywords —IoT, ESP32, MAX30102, Heart Rate Monitoring, Healthcare, SpO2.

I. INTRODUCTION

More people are facing long-term illnesses, breathing troubles, heart conditions, and similar health challenges worldwide - making tracking well-being more essential every day. Hospitals often rely on check-ups in clinics along with hands-on assessments from caregivers, yet these methods miss what happens between appointments. When vital signs go wrong without warning, waiting too long to notice can turn small issues into bigger ones. Because of this shift, devices that follow body signals steadily while moving with the person offer a clearer picture right when it matters most.

II. PROBLEM SUMMARY

Out here, gadgets talk to doctors without wires lighting up fresh paths in care. Devices share updates the moment they happen - no delays, just flow. Picture body stats moving through air into expert hands. Hospitals breathe easier when

routine checks shift outside their walls. Fewer slips occur because someone always sees what's happening right now. Machines take over tasks humans used to do by hand. Safety climbs when alerts arrive before problems grow. Information moves fast, cutting wait times across clinics. Providers stay informed even when patients are miles away. This network turns quiet warnings into loud signals on time. Right now a small device is being built to check how healthy someone really is. Instead of guessing, it uses light and pulses through skin to catch heartbeat clues plus blood oxygen hints. Built around a tiny computer called ESP32, it talks straight to home networks without extra gear. Right beside that chip sits a little screen flashing numbers the moment they're known. Information doesn't wait - it flows out over airwaves toward phones or tablets nearby. From there, anyone who cares about the person - maybe a nurse, maybe a son - can peek at trends across hours. What matters most? Watching changes quietly, day by day, without needing a clinic visit. Even sleep gets

tracked since shifts overnight often tell the true story. This setup takes up little space, moves easily, runs cheaply, yet stays powerful - ideal inside medical centers, small clinics, even private homes. Built to last through constant tracking duties, it quietly feeds progress in intelligent health systems powered by internet-connected devices.

III. SYSTEM DESIGN

Right away, heartbeat plus blood oxygen levels get watched nonstop through this connected device setup. Built around an ESP32 chip sits a MAX30102 sensor that grabs body signals on cue. Instead of just storing info locally, readings flow to a tiny screen right after capture. Right there, users see live stats without delay thanks to the built-in OLED panel. Because wireless links exist, details also travel outward using Wi-Fi pathways. Once airborne, numbers land safely inside either phone apps or online storage spots. From start to finish, one loop handles gathering facts, shaping them, showing results, then shipping updates offsite. Through it all, watching health stays ongoing - no pauses, no gaps. Heartbeats and oxygen in blood get tracked by the MAX30102 device. From light-based detection, it pulls body signals without stopping. Once captured, those readings move over to an ESP32 chip for handling. That tiny computer runs everything, making sense of incoming streams. Right there, the ESP32 takes in incoming information, showing results straight onto the small screen nearby. Meanwhile, using its own wireless feature, it pushes that health info out - off to a distant server, online system, or phone software. So doctors, helpers at home, or relatives can check how the person is doing from far away, right when it happens. When odd health signs show up - like weak oxygen flow or a shaky heartbeat - the device can sound an alarm. Right away, that signal means help might be needed fast. Small enough to carry, built without heavy expense, sipping power quietly - it fits neatly into clinics or living rooms alike. Its shape skips bulk, its needs stay modest, yet it runs steady where care happens.

MAIN COMPONENTS OF THE SYSTEM

1. ESP32 Microcontroller

Inside the system, the ESP32 runs everything. This tiny computer costs little yet sips power gently. Wireless links come alive through its native Wi-Fi and Bluetooth. Remote tracking becomes possible because signals travel without wires. Designed for smart gadgets, it fits health monitors naturally. A small chip named ESP32 grabs live body signals from a MAX30102 device, working them into useful numbers like pulse count and blood oxygen levels. Once figured out, those values appear instantly on a tiny screen wired to the system. At the very same moment, the details fly off through wireless signal, landing either in an online storage spot or inside a phone program meant to track such things. Speedy operation defines the microcontroller, while plenty of I/O pins allow smooth connections to sensors alongside screens. Reliability shows up without draining power, so devices stay lightweight yet economical on energy. Compactness plays a role, joined by built-in wireless features plus rapid data handling, which explains why the ESP32 appears often in health-focused gadgets and networked observation tools.

2. MAX30102 Sensor

Inside your finger, light changes show how much oxygen is in the blood. This tiny device tracks those shifts using red and also infrared beams. Built for wearables, it keeps an eye on pulse plus blood oxygen. Its design focuses on steady performance during movement. Efficiency matters most when power sources are small. Finger touches sensor, light slips beneath skin into tiny blood channels. Depending on how much glow gets soaked up by oxygen-rich versus oxygen-poor blood, readings form - SpO₂ and beat count snap into place. Off it goes next - the numbers ride signals straight to the ESP32 chip, where they sort out before showing up. Accuracy comes first with the MAX30102, yet it still manages to sip power while holding steady during long-term tracking. Built right into the unit - photodetectors sit beside optics and quiet electronic parts - to keep readings clean over time. Though tiny, it moves easily between gadgets, showing up in wearables where space matters most. Fitness bands lean on it just as much as hospital-grade monitors do when checking oxygen levels remotely. Even inside

smart health networks, this piece runs without fuss, handling data day after day..

3. OLED Display

Bright, sharp visuals come from an OLED screen built into the device. This kind of display runs on organic light emitting diodes - tiny lights that glow without needing a backlight. Instead of older types, it uses less energy while showing data clearly. Real time health stats appear right on this panel, visible even in sunlight. Because it sips power, battery life stretches further during continuous updates. This setup links an OLED screen to the ESP32 chip, showing key body signals like pulse and blood oxygen. Instant updates appear on screen - no phone or tablet needed. Vital signs pop up right away, giving clear feedback about current well-being. Watching your numbers becomes simple when data shows live. Info flows straight from sensor to display, cutting out extra gadgets. Seeing results fast helps track changes over time. Readings update continuously, keeping pace with real-time shifts. Most people notice how much deeper the blacks look on OLED screens - response times snap quicker than older LCDs too. Built small and light, these displays sip power instead of draining it, fitting neatly into medical gadgets you carry around plus smart home sensors. Even when lights dim, the screen stays sharp, helping eyes track details without strain. Because it's compact and works well, the OLED screen shows up often in health gear. Smart sensors rely on this tech too. Wearables fit these displays nicely thanks to their slim build. Electronics tucked into tight spaces choose them for visibility. Medical tools use the panels where clarity matters most

4. Wi-Fi Module

Wireless signals travel through air when the system checks a person's health signs. Inside this setup, the brain of the operation - the ESP32 chip - handles internet connections on its own. Instead of adding extra parts, it uses what already lives inside it. Data moves without wires because that chip talks to networks nearby. Communication happens smoothly since the design leans on what the hardware can do alone. Remote tracking works thanks to how the device links up automatically. A module isn't bolted on separately; everything fits together from the start. The way things are built means updates go out fast. Signals jump from sensor

to screen using hidden pathways in the circuit. Internet access comes alive right where the power flows. This method keeps the process light, yet strong enough for constant use. Most of the time, live updates on heartbeat and blood oxygen move straight to online platforms thanks to the wireless chip. Wherever they are, medical staff or loved ones can keep track just by opening a screen somewhere else. Without wires, moving the setup gets easier, plus it adapts faster to different spaces. A steady signal flows through the network chip, so updates arrive without delay when seconds count. Portability improves since cords stay behind, allowing smoother shifts between rooms. Information moves quickly whenever needed, especially when urgent care demands instant details. Fewer cables mean less clutter, making daily handling simpler around medical areas. Reliable links keep records within reach, even in sudden high-pressure moments. Flexibility grows because devices connect on their own terms across zones. Speed matters most during crises - data appears just as events unfold nearby. Users find navigation straightforward thanks to seamless background syncing always active. No plug-ins required helps reduce interruptions while tracking health changes live. When odd measurements show up, alerts pop up automatically through the module. Thanks to minimal energy needs, fast data transfer, slow fade into background - Wi-Fi fits neatly inside smart health setups. Remote tracking leans on it because pairing with Internet-connected gadgets feels almost effortless.

5. Cloud/Mobile Application

Out here, a mobile app hooks up with a cloud system to track health signs remotely inside an IoT setup meant for watching patients. From wherever they are, doctors or loved ones pull live updates on someone's condition using web links tied into that networked service. From the device, heartbeat and blood oxygen numbers travel through Wi-Fi to a remote server. Stored safely there, information gets sorted and prepared behind secure walls. On phones or browsers, charts and digits show what is happening over time. Each update arrives without delay, visible whenever needed. From moment to moment, the app watches how the patient is doing, recording shifts in their health along the way. When odd numbers show up, it sends out a signal - this

means help can arrive fast if something goes wrong. Out there, cloud and mobile tools help people reach care easier. Fewer trips to hospitals happen because of them. Doctors make choices faster when data arrives live. These setups stick around since they work well from anywhere. Remote access wins trust over time. Modern health tech leans on such systems quite heavily now.

IV. WORKING PRINCIPLE

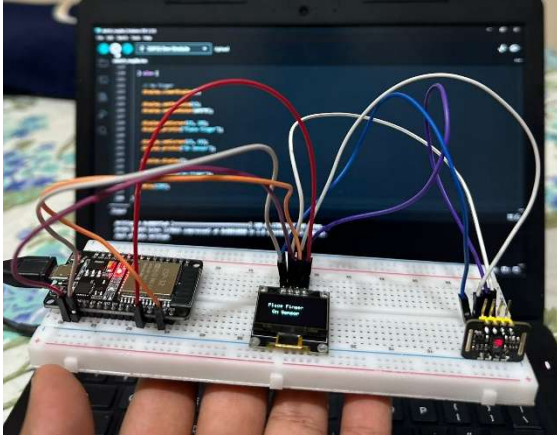


Fig. 1 Prototype of IoT Based Health Monitoring System

A small device checks key body signs like heartbeat and oxygen levels without stopping. Light from two sources - red and invisible infrared - measures changes in blood movement when a fingertip rests on it. Instead of pausing, the system turns those light readings straight into numbers. Once transformed, that information moves ahead for analysis. From the sensors, data flows into the ESP32 chip - this tiny brain refines raw signals, pulling out precise heart rate and oxygen levels. Right away, those numbers show up on the small screen built into the device, giving live feedback without delay; a glance tells you how your body is doing. From anywhere with internet, doctors or loved ones check updates sent by the ESP32's wireless signal. Health details travel straight to an app or online space after being handled on device. When odd numbers show up - say, weak oxygen flow or a wobbly heartbeat - the setup triggers alerts without delay. Right away, that means quicker care

can start while keeping watch steady and trustworthy through every moment.

V. ADVANTAGES

Real-Time Monitoring Every few seconds, it checks key signs like heartbeat and blood oxygen levels without stopping. Real-time tracking keeps tabs on vital stats the whole time.

Remote Healthcare Access From anywhere, doctors keep track of how a person is doing using online access. Caregivers check updates without being in the same room. Family stays informed thanks to live data shared over the web.

Spotting health problems early When numbers look off, spotting them fast makes it easier to catch problems early - doctors can step in right away. A small delay might mean a bigger issue later, so noticing odd results speeds things up. Quick recognition means less waiting around, which helps patients get care without holdups. Strange values stand out faster now, giving health teams a clearer path forward.

Portable and Compact Apart from being compact, it moves easily between spaces. This means hospitals use it just as much as homes do.

Low Cost Putting together parts like the ESP32 and MAX30102 keeps prices low. Because these pieces are widely available, building doesn't add up to much. What you get works well without spending extra. Each element helps hold down overall expenses. Their combined availability means fewer complications during setup. Since they connect easily, time spent assembling drops too.

Wireless Communication Out of reach for tangled cords, Wi-Fi sends data through air. Signals hop between devices, linking them quietly across rooms.

Continuous Patient Observation At any hour, alerts keep coming through - this helps older adults plus those seriously unwell. Monitoring never stops, so care stays steady when it matters most.

Low Power Consumption Some parts inside the machine need very little electricity, which helps save energy overall.

Easy Data Visualization Checking your health stats feels smooth right there on the OLED screen, through the phone app, or up in the cloud system.

Improved Healthcare Efficiency By cutting down on hands-on checks, it helps keep healthcare systems running smoother. Effort shifts from constant oversight to smarter tracking through automation

VI. FUTURE SCOPE

Imagine how often people now want health tools that work from a distance. Because of this, systems using internet-connected devices to track well-being are set to grow. Picture faster updates through smarter networks one day soon. Progress in machine learning might quietly boost how these setups understand symptoms. Security could tighten up thanks to better data storage methods online. Accuracy may rise when sensors evolve alongside software. Think about care becoming sharper without needing face-to-face visits. New tech layers will likely slip into current frameworks over time.

Integration with Artificial Intelligence (AI)

AI algorithms can be integrated to analyze patient data, predict health risks, and provide early disease detection automatically.

Monitoring of Additional Health Parameters

Future systems can include sensors for body temperature, blood pressure, ECG, glucose level, and respiration monitoring for complete healthcare analysis.

Cloud-Based Medical Data Storage

Patient health records can be securely stored in cloud databases for longterm analysis and easy access by healthcare professionals.

Mobile Application Development

Advanced mobile applications can provide real-time notifications, graphical reports, and emergency alert systems for users and doctors.

Wearable Healthcare Devices

The system can be converted into wearable devices such as smart bands or smart watches for continuous and comfortable health monitoring.

Integration with Smart Hospitals

IoT-based monitoring systems can be connected with hospital management systems for automated patient tracking and healthcare management.

Emergency Alert and GPS Tracking

Future improvements may include automatic emergency alerts and GPS location tracking for faster medical assistance during critical situations.

Machine Learning for Health Prediction

Machine learning techniques can help identify health patterns and predict diseases before severe symptoms occur.

Improved Security and Data Privacy

Advanced encryption and cybersecurity methods can be implemented to protect sensitive patient health information.

Rural and Remote Healthcare Support

The system can play an important role in providing affordable healthcare services in rural and remote areas where medical facilities are limited.

VII. CONCLUSIONS

The proposed IoT-Based Health Monitoring System provides an efficient and reliable solution for realtime monitoring of important health parameters such as heart rate and oxygen saturation level (SpO₂). By using the ESP32 microcontroller, MAX30102 sensor, OLED display, and Wi-Fi connectivity, the system enables continuous patient observation and remote healthcare monitoring. The system is portable, low-cost, energy-efficient, and user-friendly, making it suitable for both hospital and home healthcare applications. The collected health data can be monitored remotely through cloud or mobile applications, allowing doctors, caregivers, and family members to access patient information in real time. The alert mechanism also helps in providing immediate medical attention during abnormal health conditions. Overall, the proposed system reduces manual monitoring efforts, improves healthcare accessibility, and supports the development of smart healthcare technologies. With future advancements such as AI integration, wearable devices, and cloud-based analytics, IoT-based health monitoring systems can play a major role in modern healthcare and remote patient management.

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when we needed it most. They stepped in with useful feedback, kept morale up, then offered hands-on fixes whenever things stalled. Each bit of advice shaped how the system took form over time. Without that consistent backing, progress would have slowed early on. Their presence turned confusion into clarity more than once. Grateful doesn't fully cover what their involvement meant.

Grateful for the backing we got from both team and college, making it possible to finish this work. Without their steady help, getting hands-on with how IoT fits into health systems wouldn't have gone so smoothly.

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