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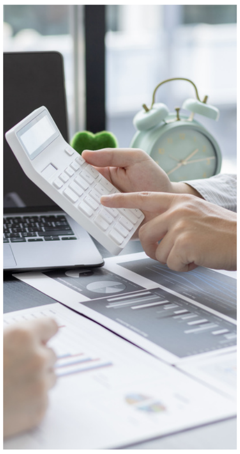
REAL-TIME SYSTEM DESIGN





Edited By

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Preface

Any information processing system having hardware and software components that execute real-time application operations and can react to events within defined time restrictions is referred to as a "real-time system." A real-time system is one that is put under real-time conditions, meaning that the system must ensure a response within a certain time frame or fulfil a deadline. For instance, real-time monitors, flight control systems, etc. Various real-time system types depending on temporal restrictions

Hard real-time systems: These systems are incapable of missing deadlines. The consequences of missing the deadline might be devastating. If tardiness grows, the utility of outputs generated by a hard real-time system dramatically declines and may even turn negative. The term "tardiness" refers to how far behind schedule a real-time system completes a job. For instance, a flight control system.

System with soft real-time: It is possible for this sort of system to sometimes miss its deadline with a tolerably low chance. Deadlines may be missed without terrible repercussions. With increasing delay, the utility of findings generated by a soft real-time system rapidly declines. Switches on phones, for instance.

Real-time system design is a difficult challenge. The fact that Realtime systems must communicate with things in the actual world is the biggest barrier. These interactions may get rather intricate. Thousands of these entities might be communicating with a typical Realtime system at once. Consider how thousands of subscribers' calls are frequently handled by a telephone switching system. Each call must be connected differently by the system. Additionally, the precise order of the call's occurrences may change significantly.

Real-time systems are required to react to outside activities in a certain period of time. The system's efficient and timely functioning is necessary for an operation to be completed successfully. Create the system's hardware and software to conform to the Realtime specifications. For instance, within the specified time limit of one second, a telephone switching system must deliver dial tone to thousands of users. The off-hook detection method and the associated software message transmission must operate within the constrained time budget in order to satisfy these criteria. These specifications must be met by the system for all calls that are made at any given moment.

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Editor

CHAPTER 1

INTRODUCTION TO REAL TIME MONITORING SYSTEM

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Infantry Soldier of Tomorrow's dystopian conflict is anticipated to be among the most ranked among the best ever. Worldwide, a number of research projects. Combining the several components into a small device that could deliver the required effects without becoming too big, heavy, or power-hungry was challenging. The troop organisation plays a significant role in careful coordination and planning. The focus of this research is thus on GPS sold position monitoring, which enables the control room station to pinpoint the exact location of the soldier and guide them via close-range, high-speed soldier-to-soldier communications. Examples of communications used to provide situational awareness knowledge include biomedical sensors, GPS, and wireless connectivity. A biosensor is created using sensors for temperature and heart rate. The whole piece of hardware and software is referred to as an "embedded system." The capacity to build a system that performs the required functions by choosing the appropriate hardware and software components is indeed the primary advantage of EM bedded systems. The basis of this project is built on the characteristics of embedded systems mentioned above. Wearable equipment that is not large and uses very little power is required in order to track the position and crucial health indicators of soldiers on the battlefield within real time. By employing this soldier navigation system, the base station soldier may be directed to their goal. The fact that this initiative is built on the Internet of Things (JOT) is its main selling point. IoT systems are networks thought up of physically or digitally connected equipment, computing devices, living things, people, and other objects with specific tasks that have the ability to transfer data across locations without the requirement for computers or human-to-computer contact [1]–[3].

The internet of things, or IoT, is a system of interconnected computers, mechanical and digital equipment, objects, animals, or people that may communicate with one another through a network without direct human or computer interaction. Things include individuals with implanted heart monitors, agricultural animals with biochip transponders, automobiles with integrated tyre pressure monitors, and other instances that can be assigned an Internet Protocol (IP) location and have the capacity to communicate data across a network. Businesses from a variety of industries are rapidly using IoT to operate more efficiently, better understand customers to provide better customer service, enhance decision-making, and increase the value of the organisations.

IoT working

The Internet of Things (IoT) ecosystem consists of web-enabled smart devices that use embedded systems, such as processors, sensors, other communication equipment, to collect, share, and act on the data they receive from their surroundings. IoT devices communicate the sensor data they collect by connecting to an IoT gateway or even other edge device, which either analyses data locally or transmits it to the cloud for analysis. These devices sometimes communicate with other, comparable devices and take action based on the information they share. The bulk of the work is done by the devices without the assistance of users, even if they may interact with them to set them

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up, provide them instructions, or retrieve information. The specific IoT applications that have been developed have a significant effect on the connectivity, connectivity, and communication protocols used by these web-enabled devices. Figure 1 illustrates how IoT might use machine learning and artificial intelligence (AI) to make the data collecting processes easier and more dynamic [1], [2], [4].

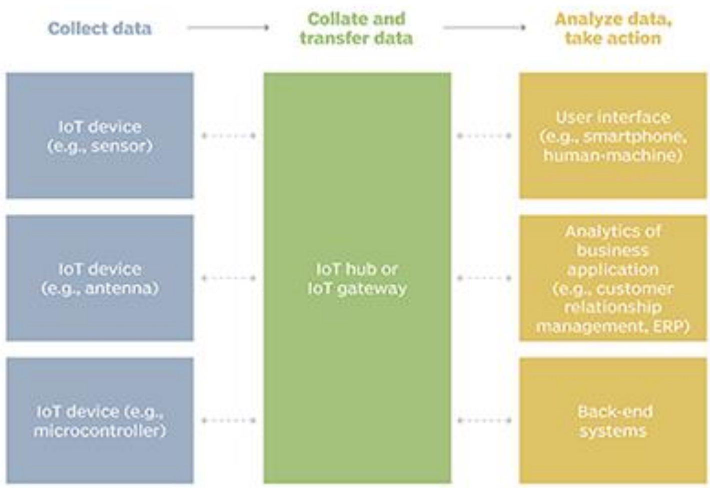

Figure 1: Illustrates the processing of data in internet of thing.

People that utilise the internet of things may lead more intelligent lives, do jobs more effectively, and have complete control over their destiny. In addition to offering smart home automation devices, IoT is essential for business. Organizations can use IoT to examine how their systems really work in real time and obtain insights about everything from equipment performance and supply chain and logistics operations. IoT enables businesses to automate processes and reduce labor costs. Additionally, it decreases the cost of producing and distributing goods, improves service delivery, minimizes waste, and offers insight into customer interactions. IoT will continue to gather pace as one of the most important technologies of everyday life as more businesses realize the potential of connected devices to keep them competitive [5], [6].

Benefits of IoT to organizations

The internet of things might provide a lot of benefits to businesses. While certain benefits are only available to particular organisations, others are relevant to several other sectors. IoT gives businesses the tools they need to improve their business plans and forces them to rethink how they run their operations. However, it has also discovered application cases for businesses in the infrastructure, home automation, and agricultural sectors that will push some businesses toward digital transformation. IoT is most common in manufacturing, transportation, and utility aspects of the company, where sensors and other IoT devices are used.

Bibliography

[1] N. Paudel and R. C. Neupane, “A general architecture for a real-time monitoring system based on the internet of things[Formula presented],” *Internet of Things (Netherlands)*, 2021, doi: 10.1016/j.iot.2021.100367.

[2] X. Yang, X. Ren, J. Lin, and W. Yu, "On Binary Decomposition Based Privacy-Preserving Aggregation Schemes in Real-Time Monitoring Systems," *IEEE Trans. Parallel Distrib. Syst.*, 2016, doi: 10.1109/TPDS.2016.2516983.

[3] W. J. Syu, T. K. Chang, and S. Y. Pan, "Establishment of an automatic real-time monitoring system for irrigation water quality management," *Int. J. Environ. Res. Public Health*, 2020, doi: 10.3390/ijerph17030737.

[4] R. Torres-Sánchez, M. T. Martínez-Zafra, N. Castillejo, A. Guillamón-Frutos, and F. Artés-Hernández, "Real-time monitoring system for shelf life estimation of fruit and vegetables," *Sensors (Switzerland)*, 2020, doi: 10.3390/s20071860.

[5] N. Q. Al-Naggar, H. M. Al-Hammadi, A. M. Al-Fusail, and Z. A. Al-Shaebi, "Design of a Remote Real-Time Monitoring System for Multiple Physiological Parameters Based on Smartphone," *J. Healthc. Eng.*, 2019, doi: 10.1155/2019/5674673.

[6] Q. Gong, Q. Wang, D. Wang, H. Qiu, and F. Wu, "Development of a Real-time Monitoring System of Cutterhead Conditions in Shield Tunnelling," *Mod. Tunn. Technol.*, 2021, doi: 10.13807/j.cnki.mtt.2021.02.006.

CHAPTER 2

SOLIDER REAL TIME HEALTH MONITORING

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The number of people who need monitoring also rises as a result of the elder population's fast growth and the lengthening of its life expectancy. Therefore, it is assumed that hospitalisation and medical treatment would become more expensive everywhere. The death rate in the US is around 770,000 per year. This applies to patients who have sentinel events as a consequence of improper medicine, dosage errors, contraindications, or crucial interventional delays that need hospitalisation. The total yearly cost of these occurrences in the US ranges from $1.5 billion to $5 billion. In order to decrease hospitalisation, the workload of medical personnel, consultation times, waiting lists, and total healthcare expenses, health monitoring systems (HMS) might be very helpful. The three categories into which health monitoring systems may be divided are listed below. Systems that may deliver data to or from a distant place are referred to as remote health monitoring systems (RHMS). This specific sort of system may be used in both hospitals and private houses, and its functionality extends from a single to many parameters that cover a variety of symptoms. Mobile phones, personal digital assistants (PDAs), and pocket PC-based systems that are utilised as the primary processing station or, in certain situations, the primary functioning module are referred to as mobile health monitoring systems (MHMS). Since they allow patients to stay in their own surroundings while getting specialised medical care, RHMS and MHMS are seen to be more practical and economical than conventional, institutional care [1]–[5].

Wearable health monitoring systems, also known as WHMS, RHMS, and/or MHMS, are wearable medical devices or biosensors that patients may wear. The term "smart health monitoring systems" (SHMS) is often used to describe cutting-edge technology or a novel method of health monitoring. They often include smart technology or a purportedly "smart" method of addressing health problems. General health monitoring systems (GHMS) are programmes that track a variety of variables including widespread illness. Heart rate (HR), blood pressure (BP), electrocardiogram (ECG), oxygen saturation (SpO2), body temperature, and respiratory rate are all considered vital indicators (RR). Rapid improvements in healthcare services and low-cost wireless connectivity over the last ten years have made it much easier to deal with the issue of fewer medical institutions. The transition of healthcare services from being clinic-centric to patient-centric has been made possible by the combination of mobile communications using wearable sensors, or "Telemedicine," as it is known in the literature. In a broader sense, there are two types of telemedicine: store and forward, which calls for the collection of medical data like vital signs, images, and videos, as well as the transmission of patient information to the appropriate hospital specialist, and live communication, which necessitates the physical presence of a physician and patient [6], [7].

Telemedicine has reportedly been used to treat patients with heart illnesses, diabetes, hypotension, hypertension, hyperthermia, and hypothermia, according to recent medical studies. The most potential use of wireless monitoring devices is in the real-time monitoring of patients with chronic conditions such cardiopulmonary disease, asthma, and heart failure who are situated distant from

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medical care facilities. Heart disease has emerged as one of the main killers of people worldwide; for example, obesity, which can have negative metabolic effects on blood pressure and cholesterol, increases the risk of heart disease, ischemic stroke, diabetes mellitus, as well as a number of common cancers, killing about 2.8 million people annually. By 2030, the WHO projects that the global prevalence of heart disease would have risen to 23.3%. Such chronic illnesses need long-term, ongoing monitoring in order to manage the hazard. For remote monitoring and off-site diagnosis, telemedicine may make advantage of the pervasive social connectedness. It should be emphasized that 6.8 billion individuals, or over 94% of the world's population, are mobile phone customers, and over 2.7 billion of those subscribers use the Internet. By the end of 2016, there may be 8.5 billion cell phone subscriptions, with 70% of smartphone owners coming from developing nations. Additionally, smartphone technology includes a number of features, including short messaging service, location tracking, and access to WLAN/GPRS/3G, which offers global connection. Numerous research on the use of mobile devices in clinical settings and healthcare demonstrate how built-in smartphone features like GPS and location-based services may help elderly patients with fragilities live independently. Other studies have discussed the advantages of current smartphone health apps while taking into account their viability for continuous data flow, portability, and power consumption. For example, in another investigation, the authors discussed the advantages of existing smartphone health apps while taking into account their credibility for continuous flow of data, feasibility, and portability. The adoption of real-time health diagnosis and monitoring through smartphone applications has been challenged by inconsistencies such battery usage, calibration, and the formation of false alerts.

Wearable sensors have been utilised as a replacement for built-in smartphone sensors enabling continuous monitoring, storing, and delivering medical data to healthcare providers across distance. Studies already conducted using wearable sensors provide monitoring for functions including physiology, biochemistry, and motion detection. These sensors have been employed to measure patients' body postures and health indicators, as well as sports as well as other activities. These wearable sensors were showing promise since they are affordable, accessible, easy to use, accurate, and dependable. Wearable sensor applications in the treatment of cardiovascular, neurological, asthmatic, and hypertensive illnesses have been the subject of several investigations. For instance, a system to track congestive heart failure in patients was created, and it included a biosensor in the shape of a ring that tracked cardiac data. Similar devices that collect acoustic impulses by putting a microphone on the patient's neck as they breathe have been developed to monitor respiratory illnesses. The framework included a band-pass filter to lessen noise and other signal distortions, which contributed to an accuracy of measurement of around 90%. The study was later expanded to include algorithmic apnea detection. By using many sensors that are combined on a single chip, wearable technology also is helpful in resolving the problems of monitoring and motion artefacts. Another type of application involves integrating many sensors on the same platform (close fitting in clothing) to monitor respiratory disorders. Although these techniques are discovered to be superior to spirometry, developments are still needed to reduce motion artefacts. Additionally, even though wearable technology has made a significant contribution to the development of healthcare monitoring systems, there are problems that might impair their effectiveness. These issues include the inability to use real-time data in monitoring systems when evaluating the application, battery problems, concerns about the security and privacy of the physician data collected, the need for medical professional recommendations for each stage of development, this same acceptability of the application by experts or the clinical community, and user acceptance for both healthcare professionals and patients. The combination of mobile networks and wearable technology may open up new possibilities for the quick, dependable, and secure sharing of medical data.

Bibliography

[1] K. I. Mohammed *et al.*, “Real-Time Remote-Health Monitoring Systems: a Review on Patients Prioritisation for Multiple-Chronic Diseases, Taxonomy Analysis, Concerns and Solution Procedure,” *Journal of Medical Systems*. 2019. doi: 10.1007/s10916-019-1362-x.

[2] Q. Dong, Z. Guan, K. Gao, and Z. Chen, “SCRHM: A secure continuous remote health monitoring system,” *Int. J. Distrib. Sens. Networks*, 2015, doi: 10.1155/2015/392439.

[3] W. CHEN, “Design of a Remote Health Monitoring System Based on Wireless Sensor Networks,” *DEStech Trans. Eng. Technol. Res.*, 2017, doi: 10.12783/dtetr/amma2017/13376.

[4] D. Sathya and P. G. Kumar, “Secured remote health monitoring system,” *Healthc. Technol. Lett.*, 2017, doi: 10.1049/htl.2017.0033.

[5] M. Z. Islam, S. H. Rafi, and M. M. Miah, “Remote Health Monitoring System using Wireless Body Area Network,” *Glob. J. Res. Eng.*, 2019, doi: 10.34257/gjrejvol19is1pg1.

[6] S. Kodam, N. Bharathgoud, and B. Ramachandran, “A review on smart wearable devices for soldier safety during battlefield using WSN technology,” 2020. doi: 10.1016/j.matpr.2020.08.191.

[7] Y. Jain, B. Soni, A. Goyal, and C. Sharma, “Novel wearable device for health monitoring and tracking of soldiers based on LoRa module,” 2020. doi: 10.1109/CICT51604.2020.9312084.

CHAPTER 3

BLOCK DIAGRAM SOLIDER HEALTH MONITORING AND TRACKING SYSTEM

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Heart rate and temperature monitoring Figure 1 Block Diagram again for Cloud: Power Source Buzzer Microcontroller LCD Display GPS EMG Button LED WIFI The preceding module shows the design of the system for monitoring military positions, health, and environmental evaluation. Due to the need for a high-speed connection, Arduino Uno is the intended platform. To monitor a person's health, biosensors like regular temperature and pulse rate sensors are integrated with processors. The GPS receiver records the soldier's location (longitude and latitude) and stores it in the microcontroller storage. A GPS receiver contrasts the signal it received from such an orbiting GPS satellite to determine a place's geographic position. We might use the keypad to indicate an emergency. Additionally, it sends information to the army base station that includes the health parameter [1], [2].

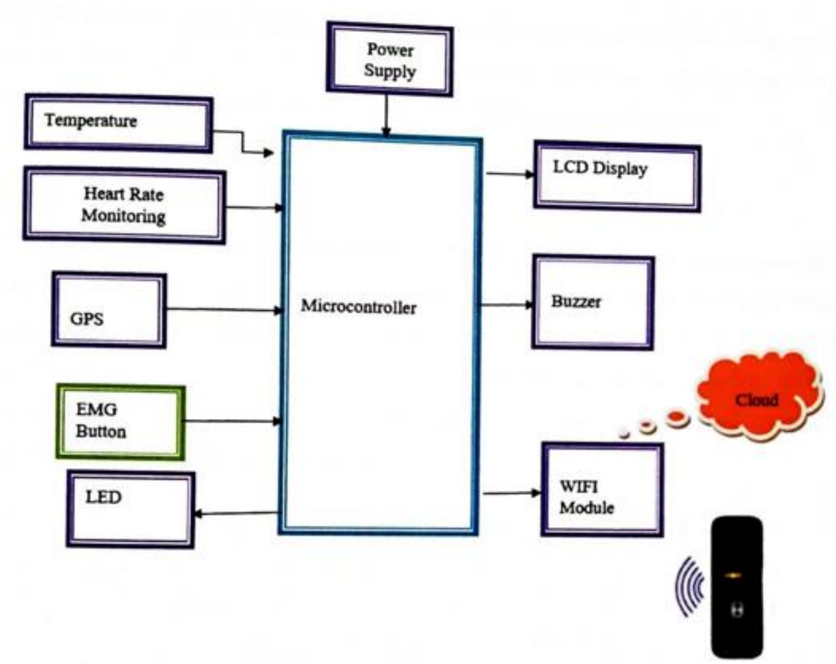

Figure 1: Illustrates the Block diagram solider health monitoring and tracking system.

Through the GPS receiver, the base station unit gets data about the soldier unit, and using IoT-integrated software, the location and health status of the soldier are presented on the base station's computers. The gathered data may also be viewed on mobile devices using MIT App Inventor. The LCD display displays the soldier's temperature, pulse rate, and location. The cloud object spoke and viewed at the military base camp will get the output from the heart rate sensor, temperatures, and latitude and longitude.

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Arduino Uno

The term "Arduino" refers to both the programming software and an open-source motherboard or electrical platform. Everyone interested in creating interactive objects or environments, including artists, designers, hobbyists, and others, will have simpler access to electronics with the aid of Arduino. An Arduino board may well be purchased fully built or made by hand due to the open source nature of hardware design [3]–[6]. Users may personalize the boards to meet their needs by updating and sharing their own versions of them. Figure 2 displays a variety of controllers and microprocessors utilized in Arduino board designs for the Digital O Uno Board (Arduino Uno). The modular's sets of digital and analog input/output (I/O) pins may be used to interact with a wide range of association for the advancement, circuit boards (shields), and other circuits. The boards include serial communication ports that can be used to download software through personal computers, including some versions of a Universal Serial Bus (USB). The microcontrollers are often programmed using a dialect of the programming languages C and C++.

Figure 2: Illustrates the circuit board of Arduino Uno.

A platform for hardware and software prototyping, Arduino is free and open-source. An Arduino board may be used to take inputs such as light on a sensor, a fingertip on a button, or a tweet, and then be used to start a motor, switch on an LED, or publish anything online. Their board will receive instructions from the microcontroller when a series of commands are sent to it. You do this by using the Processing-based Arduino Software (IDE) and the Wiring-based Arduino Programming Language. Arduino was developed at the Ivrea Interaction Design Academy as a straightforward tool for fast prototyping targeted at students with no previous knowledge of electronics or programming. As its user base grew, the Arduino board started to develop, expanding from simple 8-bit boards to products for Internet of Things (IoT) applications, wearable technologies, 3D printing, and embedding settings. Each and every Arduino board was completely open-source, allowing users to build them independently and eventually adapt them to meet their own needs. Additionally, the application is open-source, and users from across the world help it expand.

Advantages of Arduino

Additionally, Arduino means working with microcontrollers simpler, but for educators, students, and interested hobbyists, it provides a number of benefits over alternative platforms:

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In terms of cost, Arduino boards are competitive with other microcontroller designs. The cheapest Arduino module may well be put together by hand, and even pre-assembled Arduino modules costing less than $50.

Cross-platform: Android, Macintosh OS X, and Linux are all compatible with the Arduino Software (IDE). Most microcontroller systems run only on Windows.

Simple to use and comprehend programming environment - The Arduino Software (IDE) is flexible enough to be utilized by both new and seasoned users. Because it is based on the Processing application architecture, students learning how program in that environment would be familiar with how the Arduino IDE works, which is useful for teachers. Open source software with the ability to be extended - The Arduino software is made accessible via open source tools that can be extended by skilled programmers. C++ libraries may be used to improve the language.

Bibliography

[1] P. Chakravarth, S. Natarajan, and M. Anto Bennet, "GSM based soldier tracking system and monitoring using wireless communication," *Int. J. Smart Sens. Intell. Syst.*, 2017, doi: 10.21307/ijssis-2017-250.

[2] Y. Jain, B. Soni, A. Goyal, and C. Sharma, "Novel wearable device for health monitoring and tracking of soldiers based on LoRa module," 2020. doi: 10.1109/CICT51604.2020.9312084.

[3] F. Hidayanti, F. Rahmah, and A. Wiryawan, "Design of motorcycle security system with fingerprint sensor using arduino uno microcontroller," *Int. J. Adv. Sci. Technol.*, 2020.

[4] J. Susilo, A. Febriani, U. Rahmalisa, and Y. Irawan, "Car parking distance controller using ultrasonic sensors based on arduino uno," *J. Robot. Control*, 2021, doi: 10.18196/jrc.25106.

[5] A. P. U. Siahaan *et al.*, "Arduino Uno-based water turbidity meter using LDR and LED sensors," *Int. J. Eng. Technol.*, 2018, doi: 10.14419/ijet.v7i4.14020.

[6] R. Wahyuni, J. T. Sentana, Muhardi, and Y. Irawan, "Water level control monitoring based on arduino uno R3 ATMega 238p using Lm016l LCD at STMIK Hang Tuah Pekanbaru," *J. Robot. Control*, 2021, doi: 10.18196/jrc.2489.

CHAPTER 4

OPEN SOURCE AND EXTENSIBLE HARDWARE

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Due to the Creative Commons license that the Arduino board plans are released under, skilled circuit designers are able to create their own version of the module, expanding and improving upon it. Even relatively novice users may construct the module's breadboard version throughout order to comprehend its operation and save money.

Heart Rate Sensor

Since the beginning of medicine, the heart rate, also known as pulse rate, has been acknowledged as a vital indicator and has been closely linked to a person's cardiovascular health. And used an Arduino board and the Easy Pulse sensor in Figure 1, they will construct a PC-based heart rate monitoring system today. Easy Pulse is a pulse sensor that detects the pulse signal from a fingertip using the transmitted photo-plethysmography (PPG) concept. The Arduino board reads the sensor output before sending the information to the PC through with a serial port. Heart rate monitors were tools that can continually detect and measure your heart rate or pulse. Many of these wearable gadgets are quite precise. Although these gadgets might be useful for keeping an eye on your health, people shouldn't use them in lieu of medical attention since they aren't as precise as licensed medical equipment. Devices that detect and monitor human heart or pulse rate are called heart rate monitors. These gadgets are compact, wearable, and many of them employ very precise sensors thanks to technological advancements. These tools are great for home usage, but they can't replace medical tools since they are considerably more precise. Heart rate monitors are a highly common element in wearable technology, such as fitness trackers and smartwatches. Many of these gadgets can wirelessly link up with PCs and cellphones. This makes it simple for consumers to evaluate their heart-rate data [1]–[3].

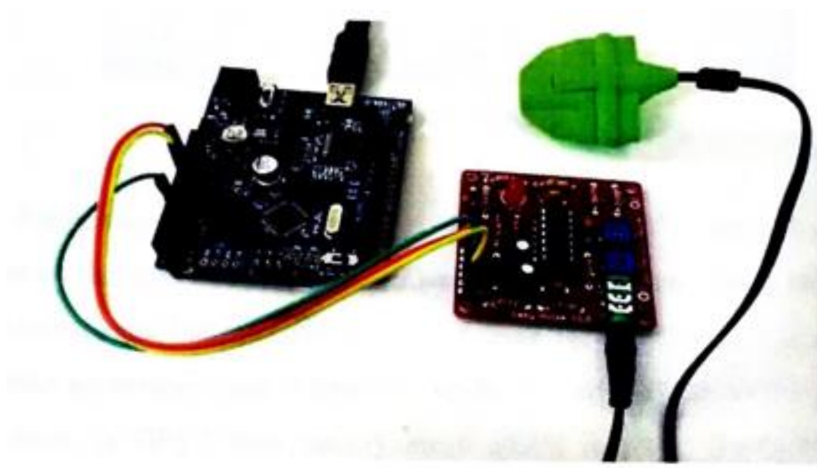

Figure 1: Illustrates the circuit board of heat rate sensor.

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Devices Working

So can monitor the activity of your heart using both pulse and heart rate. The number of times your heart beats in a minute is your heart rate. Your heart beats a certain number of times per minute, which causes your arteries to dilate. This is your pulse rate. Usually, there is no difference between your heart rate with pulse rate (or the difference is very small). This pulse in your arms, however, might become more difficult to feel depending on overall health, your medicines, or the environment. That could obstruct these gadgets' functionality. Devices that can measure your heart rate or pulse rate are referred to as "heart rate monitors." These gadgets use two alternative strategies:

Electrical (electrocardiography): With each beats, your heart produces a little electrical current. Electrically capable heart rate monitors can find and measure that current [4]–[6].

Infrared light is used by optical (photo) plethysmography equipment to show how your arteries enlarge when their heart pumps blood through them. These gadgets monitor your heart rate, and some of them can calculate your blood's oxygen content.

Common types of devices

The several devices are categorized as:

Chest-band devices

These gadgets measure your heart rate via electrical sensing. Through a band that is wrapped over upper chest, they may detect electrical activity. The majority of these gadgets need you to wear a wet band or conductive gel where the sensors contact human skin in order for them to function as intended. Electrical conduction is improved by water or conductive gel, making it simpler for the gadget to detect the electrical current flowing through your heart.

Wrist- or forearm-worn wearables

Ones forearm and wrist contain two significant arteries. The light pink and ring fingers are served by the ulnar artery, while your thumb is served by the radial artery. The skin on the substratum of your forearm and wrist receives a lot of blood flow from these 2 different arteries. Light-emitting diodes (LEDs) and sensors are built into these wearables as well as rest against the skin there. The sensor detects the minute blood vessel expansions beneath the skin's surface using LED light.

Smart Rings

These are accessories that people put on one of your fingers and wear like jeweler. They also monitor your heart rate as well as other vital indicators via optical detection. There is little information on the accuracy of these gadgets since they are still quite new.

Pulse Oximeters

These devices likewise use the optical detecting technique, with many of them being clip-on devices. These monitor blood oxygen levels and pulse rate. Although they are often used in healthcare facilities, users may also purchase portable, battery-powered variants of these devices for personal use.

Smartphones

Anyone can check your pulse rate using a number of smartphone applications on various platforms. Holding your finger in front of the camera lens, some of these devices employ optical detection to determine actual heart rate while the flash of a camera is used to light the blood vessels beneath human skin. Others utilise the camera itself directed at your face to measure your heart rate using changes within your skin that are visible but can't be seen with the naked eye.

Bibliography

[1] S. Jiang, P. Pan, Y. Ou, and C. Batten, "PyMTL3: A Python Framework for Open-Source Hardware Modeling, Generation, Simulation, and Verification," *IEEE Micro*, 2020, doi: 10.1109/MM.2020.2997638.

[2] N. J. Kinar and M. Brinkmann, "Development of a sensor and measurement platform for water quality observations: design, sensor integration, 3D printing, and open-source hardware," *Environ. Monit. Assess.*, 2022, doi: 10.1007/s10661-022-09825-9.

[3] A. G. Millard *et al.*, "ARDebug: An augmented reality tool for analysing and debugging swarm robotic systems," *Front. Robot. AI*, 2018, doi: 10.3389/frobt.2018.00087.

[4] J. Kokert, T. Beckedahl, and L. M. Reindl, "Medlay: A reconfigurable micro-power management to investigate self-powered systems," *Sensors (Switzerland)*, 2018, doi: 10.3390/s18010259.

[5] M. Zaffar *et al.*, "VPR-Bench: An Open-Source Visual Place Recognition Evaluation Framework with Quantifiable Viewpoint and Appearance Change," *Int. J. Comput. Vis.*, 2021, doi: 10.1007/s11263-021-01469-5.

[6] S. Tennina, O. Gaddour, A. Koubâa, F. Royo, M. Alves, and M. Abid, "Z-Monitor: A protocol analyzer for IEEE 802.15.4-based low-power wireless networks," *Comput. Networks*, 2016, doi: 10.1016/j.comnet.2015.12.002.

CHAPTER 5

PULSE SENSOR

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The Easy Pulse sensor is intended to demonstrate the photo plethysmography (PPG) concept as a non-invasive optical technology for sensing cardio-vascular pulse wave from such a fingertip in educational and recreational settings. On one side, an infrared source of light illuminates the finger, while on the other, a photodetector monitors any little fluctuations in the intensity of the light transmitted. Changes in the blood volume from the inside of the tissue are correlated with differences in the photodetector output. The data is cleaned up and boosted to create a PPG waveform that beats in time with the heartbeat.

GPS System

As a cooperative civil and military technology effort, the Global Positioning System—previously known as that of the Navistar Global Positioning System—began in 1973. To lessen the proliferation of navigational aids, the joint initiative merged the finest features of numerous service-centric capabilities, notably TRANSIT, TIMATION, but also Project 621B. The development of a system that circumvented the drawbacks of several other navigation systems led to the appeal of GPS to a wide range of users worldwide. Virtually most navigation and timing operations have found success with the Global Positioning System (GPS), and because it capabilities can be accessed with compact, affordable equipment, GPS is being employed in a broad range of applications throughout the world. With an unhindered lines of sight to four or even more GPS satellites, the Global Positioning System (GPS) is indeed a space-based satellite communication system that transmits position and timing information throughout all weather conditions, anywhere on or near the Earth. Anyone who has a GPS receiver may freely access it because it is maintained by the US government [1]–[3].

Typically, when someone refers to "a GPS," they mean a GPS receiver. The actual constellation of the Global Positioning System (GPS) consists of 27 Earth-orbiting satellites (24 in operation and three extras in case one fails). This satellite network was created and put into use by the U.S. military as a military navigation system, however it was quickly made available to the general public. These solar-powered satellites, which weigh between 3,000 and 4,000 pounds each, travel 12,000 to 19,300 kilometers every day, doing two full revolutions. At all times, wherever on Earth, there are always least four satellites observable in the sky because to the way the orbits are set up. A constellation of satellites transmitting navigational signals as well as a network of earth stations including satellite control stations used mostly for monitoring and control make up the Global Positioning System (GPS), a space-based radio navigation system. At the moment, 31 GPS satellites are in orbit around the Earth at a height of around 11,000 miles, giving users precise information on location, velocity, & time any place on the globe and in any weather. The Department of Defense manages and operates GPS (DoD). In order to make sure that the GPS system takes into account both civilian and military needs, the National Space-Based Positioning,

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Navigating, and Timing (PNT) Executive Committee (EXCOM) advises the DoD on topics affecting federal agencies that are connected to GPS. The EXCOM is co-chaired by the DoD as well as the Department of Transportation. In terms of GPS issues, the U.S. Coast Guard serves as that of the civil user's point of contact with the general public and receives problem complaints from them. GPS in civil aviation is regulated by the Federal Aviation Administration, which also accepts complaints of issues from aviation users [4]–[6].

Temperature Sensor

A temperature sensor is a thermocouple or even a resistance temperature detector (RTD) that collects the temperature from a particular source and modifies the obtained data into comprehensible form for a device or observer. Figure 1 Temperature Sensor shows some of the uses for temperature sensors, including HV and AC system pollution regulations, medical equipment, food processing elements, chemical handling, regulating systems, and vehicle under-hood monitoring. Temperature sensor LM35 an electrical o/p compared to the temperature (in °C) can be used to measure temperature with the help of a temperature sensor like the LM35, which is a kind that is often employed. When compared to a thermistor, it can measure temperature more accurately. This sensor produces an output voltage that is higher than that of thermocouples, hence it may not be necessary to amplify the output voltage. The output voltage of the LM35 is inversely proportional to the Celsius temperature. There is a.01V/°C scale factor. The LM35 maintains an accuracy of +/-0.4°C at ambient temperature and +/-0.8°C throughout a range of 0°C to +100°C without requiring any external calibration. Another important feature of this sensor is that it only uses 60 micro amps from its power source and has a low self-heating capability. The LM35 temperature sensor is offered in several packaging options.

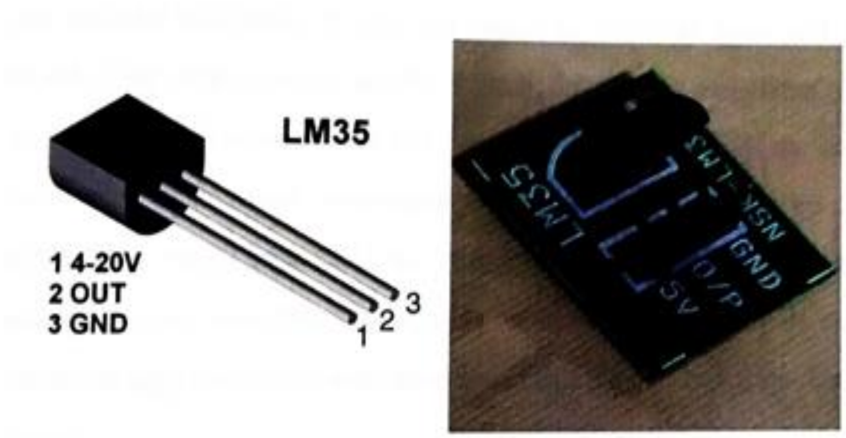

Figure 1: Illustrates the three pin relay of temperature sensor.

Different Types of Temperature Sensor

Thermistors can be very small in size

They contain two wires so they may be linked to an electrical circuit and a sensing device that can be either glass or epoxy coated. By tracking changes in the resistance of a electric current, they can estimate temperature. NTC or PTC thermometers are both available, and they are often inexpensive.

RTDs or Resistance Temperature Detectors

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It measures ohmic resistance to gauge temperature in a manner similar to thermometers. They are linked to a circuit in a manner similar to that of a thermistor, they are able to measure very high temperatures and have a significantly larger temperature range.

Thermocouples

It employs two conductors, each manufactured of a unique metal, which are linked at one end to create a junction. A voltage that is exactly proportional to the temperature source is generated when this junction is heated. They are the least accurate of the three kinds of sensors because they lack the fine precision of NTCs and RTDs but are very adaptable since various metal combinations enable for varied measurement ranges.

Temperature Probes

It is a widely used and different kind of temperature sensor. They may be completed with a terminal head and include a thermistor, thermocouple, or RTD sensing element. All three sensor types may be produced into both standard and custom housing types. This enables improved usefulness across a wide range of various locations and media which they come across.

Bibliography

[1] H. Ouyang *et al.*, "Self-Powered Pulse Sensor for Antidiastole of Cardiovascular Disease," *Adv. Mater.*, 2017, doi: 10.1002/adma.201703456.

[2] L. Xu *et al.*, "Self-powered ultrasensitive pulse sensors for noninvasive multi-indicators cardiovascular monitoring," *Nano Energy*, 2021, doi: 10.1016/j.nanoen.2020.105614.

[3] H. A. Rahim, A. Dalimi, and H. Jaafar, "Detecting drowsy driver using pulse sensor," *J. Teknol.*, 2015, doi: 10.11113/jt.v73.4238.

[4] Y. Irawan, Y. Fernando, and R. Wahyuni, "Detecting Heart Rate Using Pulse Sensor As Alternative Knowing Heart Condition," *J. Appl. Eng. Technol. Sci.*, 2019, doi: 10.37385/jaets.v1i1.16.

[5] J. Yan *et al.*, "Reflection-type photoplethysmography pulse sensor based on an integrated optoelectronic chip with a ring structure," *Biomed. Opt. Express*, 2021, doi: 10.1364/boe.437805.

[6] H. H. Jang, J. S. Park, and B. Choi, "Flexible piezoresistive pulse sensor using biomimetic PDMS mold replicated negatively from shark skin and PEDOT:PSS thin film," *Sensors Actuators, A Phys.*, 2019, doi: 10.1016/j.sna.2018.12.015.

CHAPTER 6

LIGHT EMITTING DIODE (LED)

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The 3mm LED is one of several different sizes and shapes that are offered for the LEDs. We have a large selection of the most popular 3mm, 5mm, 8mm, and 10mm types. The LED's outside diameter is referred to as its size. The smallest LEDs, 3mm, are utilised in tiny spaces, while 8mm and 10mm types are employed in places where you want to emit as much light as you can. The extraordinarily brilliant 3mm super bright LEDs are perfect for use in models, illuminations, headlights, spotlights, and automobile lighting. Anywhere that requires a dependable, high-intensity, low power light or indicator may employ mm LEDs. They fit onto a breadboard with ease. Locate the LED Terminal Leads in Figure 1. A positive (Anode) lead as well as a negative (Cathode) lead are both present in an LED. With the exception of two arrows pointing outward, the architectural symbol of the LED is identical to that of the diode. A triangle and a line are used to indicate the anode (+) and cathode (-), respectively. An LED's positive (Anode) lead is often longer than its negative (Positive) lead (cathode). The LED is a forward-current-switching PN-junction diode that produces light whenever an electric current flows through it. Reproduction of the charge carrier occurs in the LED. When the N-side electron and the P-side hole unite, energy is produced in the form of light and heat. The LED emits light via the junction of a diode and is formed of colorless semiconductor material. The LEDs are widely employed in numeric and alphanumeric characters arrays and dot matrix displays. For each line segment, many LEDs are employed, but just one LED is used to create the decimal point [1]–[3].

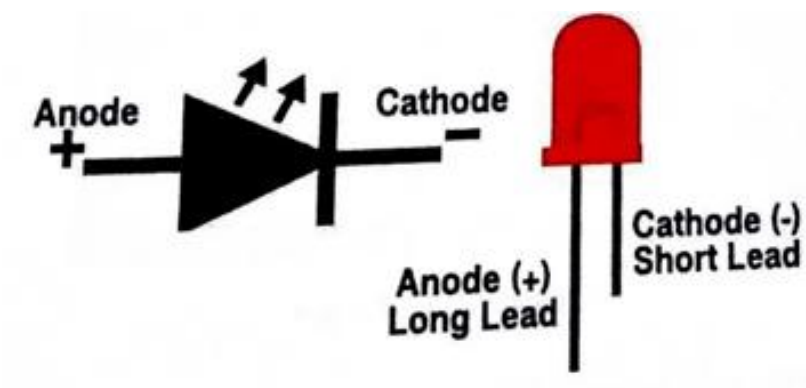

Figure 1: Illustrates the schematic diagram of LED.

Construction of LED

The P-type material is where the charge carrier recombination takes place, hence the surface of a LED is made of P-type material. The anode was deposited near the P-type material's edge for optimal light emission. The cathode, which is formed of gold film, is often positioned near the N-base. Region’s the cathode's gold coating aids in light reflection at the surface. Creating LEDs that

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create red or yellow light requires the usage of gallium arsenide phosphide. In Figure 2, you may also find LEDs in green, yellow, amber, and red [4]–[6].

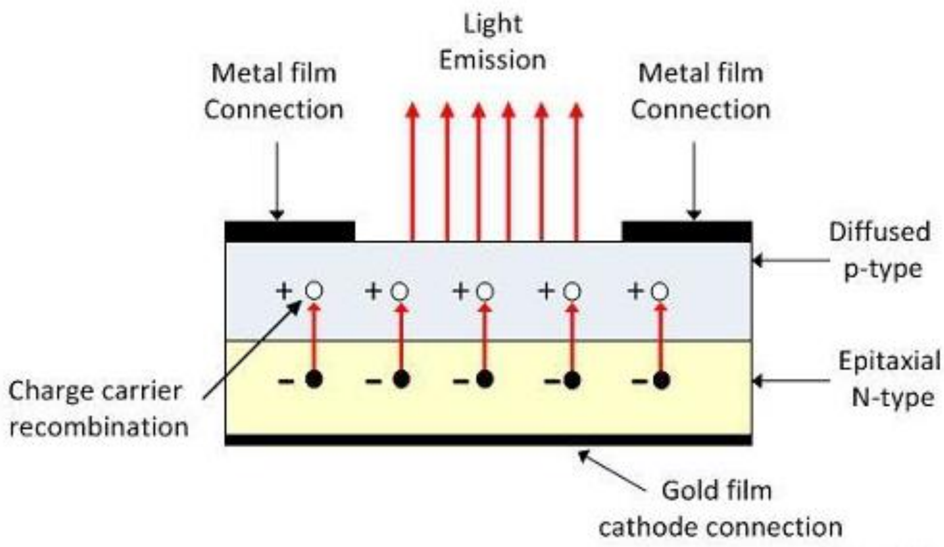

Figure 2: Illustrates the construction of light emitting diode.

The quantum theory is a factor in how the LED functions. According to the quantum theory, photons are released when electron energy declines from a higher level to a lower one. The difference between both the higher and lower level is equivalent to the energy of the photons. Since the LED is wired in a forward-biased manner, electricity may flow in that direction. The migration of electrons throughout the opposite direction causes the current to flow. The recombination demonstrates how the electrons transition from the conduction band towards the valence band and release photons, which are units of electromagnetic energy. The distance between the valence and conduction bands band determines the energy of photons.

Buzzer

The buzzer's pin arrangement. It has two pins: a positive pin and a negative pin. The "+" sign or a longer terminal is used to indicate this's positive terminal. The positive terminal is represented by the "+"symbol or long terminal and is linked to the GND terminal, whereas this terminal is supplied by 6 volts. A piezo buzzer is a kind of electrical instrument used often to create sound. It may be used in a variety of applications, including computers, call bells, cars and trucks with reversing indicators, and basic, low-cost construction. The piezo buzzer is dependent on the inverse principles of piezo electricity, which Jacques and Pierre Curie discovered in 1880. When some materials are subjected to mechanical pressure, it is a phenomenon that causes electricity to be produced, and the opposite is also true. These substances are referred to as piezoelectric materials. Materials for piezoelectric devices may be created artificially or organically. A kind of man-made material known as piezo ceramic exhibits the piezoelectric phenomenon and is often utilised to create the piezo buzzer's disc. They stretch or contract in line with both the frequency of the signal when exposed to an alternating electrical field, creating sound. The reverse piezoelectric action is the basis for the piezo buzzer's sound production. The core idea is to apply electric potential across such a piezoelectric material to generate pressure fluctuation or strain. These buzzers may be used to notify a user of a situation related to a sensor input, counter signal, or switching action. When a voltage is placed across these crystals, they pushed on one conductor and pull on another, which is employed in alarm systems. A sound wave is created by this action of pushing and pulling.

Bibliography

[1] Q. Dong, L. Lei, J. Mendes, and F. So, “Operational stability of perovskite light emitting diodes,” *JPhys Materials*. 2020. doi: 10.1088/2515-7639/ab60c4.

[2] M. Usman, M. Munsif, U. Mushtaq, A. R. Anwar, and N. Muhammad, “Green gap in GaN-based light-emitting diodes: in perspective,” *Critical Reviews in Solid State and Materials Sciences*. 2021. doi: 10.1080/10408436.2020.1819199.

[3] J. Lu *et al.*, “Ultrathin PEDOT:PSS Enables Colorful and Efficient Perovskite Light-Emitting Diodes,” *Adv. Sci.*, 2020, doi: 10.1002/advs.202000689.

[4] D. Wang, C. Cheng, T. Tsuboi, and Q. Zhang, “Degradation mechanisms in blue organic light-emitting diodes,” *CCS Chemistry*. 2020. doi: 10.31635/ccschem.020.202000271.

[5] N. K. Kumawat, D. Gupta, and D. Kabra, “Recent Advances in Metal Halide-Based Perovskite Light-Emitting Diodes,” *Energy Technology*. 2017. doi: 10.1002/ente.201700356.

[6] G. Li *et al.*, “Highly Efficient Perovskite Nanocrystal Light-Emitting Diodes Enabled by a Universal Crosslinking Method,” *Adv. Mater.*, 2016, doi: 10.1002/adma.201600064.

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CHAPTER 7

WI-FI MODULE

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The ESP8266 Wi-Fi Module, a self-contained SOC with either an integrated TCP/IP protocol stack, allows any microcontroller to communicate to a Wi-Fi network. The ESP8266 is unable to host any application or offload the whole of Wi-Fi networking activities to another central processing unit. Any microcontroller may connect to your Wi-Fi network with both the ESP8266 Wi-Fi Module, a self-contained SOC either with or without an integrated TCP/IP protocol stack. The ESP8266 is unable to host an application or offload the whole of Wi-Fi networking activities to some other central processing unit. All you have to do to get roughly the same amount of Wi-Fi capability as a Wi-Fi Shield (and that's right out of the box) with an ESP8266 module is attach it to your Arduino project! Each ESP8266 module comes pre-programmed when using an AT command set firmware. A particularly cost-effective board with such a large and growing community is indeed the ESP8266 module. Thanks to its strong on-board processing and storage capability, this module can be connected with sensors as well as other application-specific components via its GPIOs with a minimal of upfront programming and realtime loading. It only needs a tiny amount of additional external circuitry because to the high degree of on-chip integration, as well as the front-end module was designed to occupy up little space just on PCB [1]–[4].

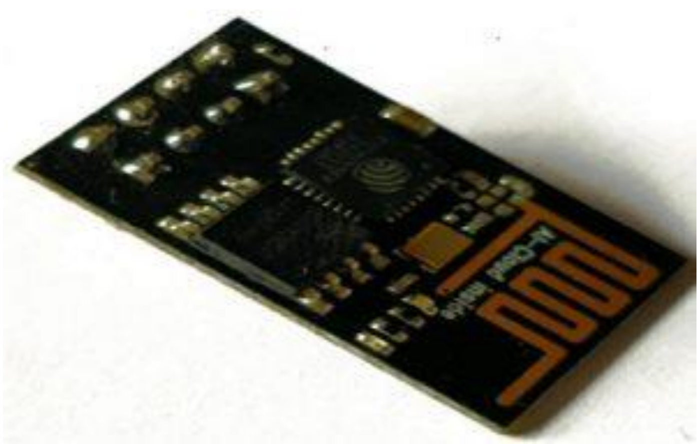

Figure 1: Illustrates the schematic diagram of Wi-Fi module of ESP8266.

Because of its self-calibrating RF, the ESP8266 can function in any environment and doesn't need any extra RF components. Additionally, it supports Bluetooth co-existence interfaces and APSD apps that enable VoIP. Espresso Systems developed the ESP8266 Wi-Fi modules to provide both TCP/IP capability and microcontroller access to any Wi-Fi network. It provides solutions that meet the cost, power, functionality, and architectural demands of the IoT sector. It may run alone or as a slave program. If the ESP8266 Wi-Fi is just acting as a slave to something like a microcontroller host, it may be used as a Wi-Fi adaptor to any type of microcontroller that uses UART or SPI. When used as a standalone application, the module serves as both a microcontroller and a Wi-Fi networking device. RF balun, power modules, conventional receiver & transmitter amplifiers, filtration, digital baseband, resource modules, external circuits, as well as other crucial parts are all included in the ESP8266 Wi-Fi module's highly integrated architecture, which is seen in Figure 1.

Things speak features

With the use of the IoT analytics platform Thing Speak, anybody may collect, evaluate, and analyze real-time data streams inside the cloud. Thing Speak quickly visualizes data given by your gadgets to it. The phrase "Internet of Things" (IoT) describes a recent development in which a sizable number of embedded devices are connected to the Internet. These data-sharing devices often transfer sensor data to cloud storage / internet computing resources for processing and analysis in order to provide important insights. Affordable cloud computing capability and enhanced device connectivity enable this development. Figure 2 displays some of the vertical IoT applications, such as home automation, environmental control and monitoring systems, and fleet able to monitor [5]–[7].

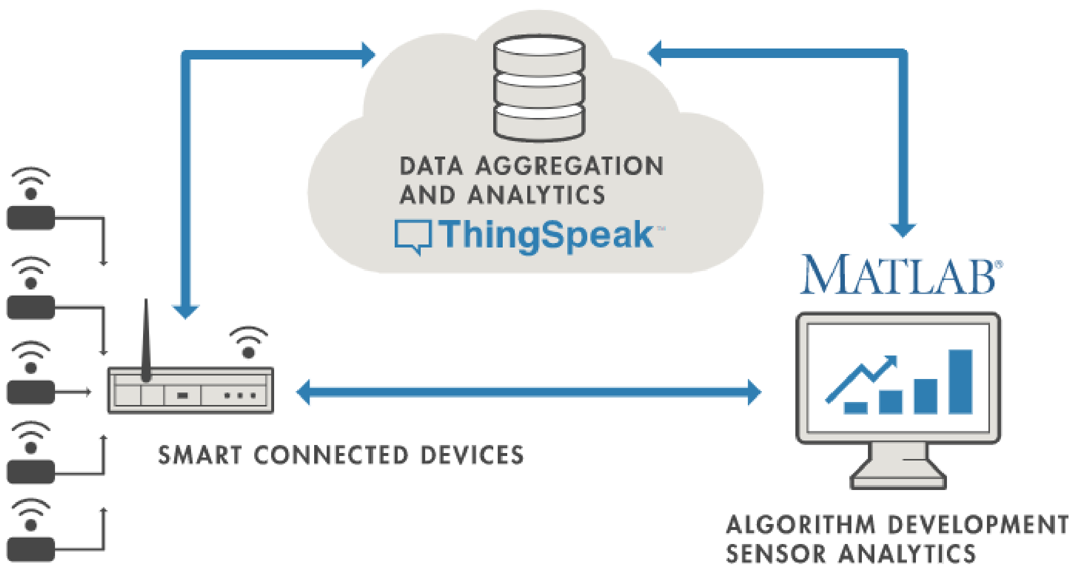

Figure 2: At a high level, many IoT systems can be described using the diagram.

On the left, you can see the IoT "things" smart devices that are located at the network's edge. Devices that collect data include factory floor equipment, wearable technology, wireless temperature monitoring, heart rate monitors, and hydraulic pressure sensors, to name just a few. The hub of our system is the cloud, where information from multiple sources is gathered and assessed right away, often by specialist IoT analytics platforms designed for this purpose. The right half of the picture displays the algorithm development for the IoT application. A data scientist and engineer often makes an effort to comprehend the acquired data by conducting historical studies on the data. The data is obtained from the IoT platform and put into a desktop software environment to enable the engineer or investigator to prototype algorithms that may eventually operate in the cloud or inside the smart device itself. An IoT system is made up of all of these

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parts. Thing Speak, which is in the cloud section of the diagram, provides a platform for quickly data collection and analysis from internet-connected sensors. Devices may be configured to provide data into Thing Speak using easy IoT protocols. Visualization of unique sensor data in real-time. Aggregate data from other sources as needed. Making use of MATLAB's strengths, make sense of the present IoT data. Automate IoT analytics based on schedules or occurrences. It is possible to prototype and develop IoT solutions without the need of servers or web apps.

Bibliography

[1] G. O. Tae, H. Y. Chung, and S. K. Gyu, “Esp8266 Wi-Fi module for monitoring system application,” *Glob. J. Eng. Sci. Res.*, 2017.

[2] T. Sudheer Kumar and V. V. R. Rao, “Voice Controlled Robot Using Wi-Fi Module,” *Int. Res. J. Eng. Technol.*, 2020.

[3] C. Kim and G.-S. Kim, “Experimental Study of a Wi-Fi Module for Radon Data Communication,” *Int. J. Trend Sci. Res. Dev.*, 2017, doi: 10.31142/ijtsrd8277.

[4] M. Sabari, P. Aswinth, T. Karthik, and C. Bharath Kumar, “Water Quality Monitoring System Based on IoT,” 2020. doi: 10.1109/ICDCS48716.2020.243598.

[5] J. Griffin, “What do happiness studies study?,” *J. Happiness Stud.*, 2007, doi: 10.1007/s10902-006-9007-4.

[6] J. M. Torres, R. M. E. Matildo, R. A. Somblingo, M. R. D. Santos, and E. O. Alieto, “Another look at the Phonological Features of Lectal Speakers: Re-validation of the Description of the Philippine English’s Phonology,” *TESOL Int. J.*, 2021.

[7] H. Ghanbari (Odivi), “Toward Designing and Implementing Language Revitalization Programs in Academia and Community,” *Open J. Mod. Linguist.*, 2020, doi: 10.4236/ojml.2020.106054.

CHAPTER 8

INTRODUCTION TO TRAFFIC VIOLATION USING NEURAL NETWORKS

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In a nation with a high population density like India, traffic offences are widespread. In important cities like Delhi, Mumbai, Bangalore, and Chennai, the situation is far worse. These behaviours lead to accidents that cause significant loss of life and property. Traffic control agents are having a harder time locating offenders in the middle of the confusion. As a remedy to this issue, we have pictures of people who disregard traffic restrictions. With such photographs, we can file against them just fine, but it's impossible to recognise people or car numbers due to the poor quality. We are using an image enhancement approach to produce higher-resolution pictures to address this issue. Due to and assuming some notable developments in the field, interest in deep learning-based language modelling has surged recently. As we may already know, there are various conventional methods for improving picture resolution. Combining the vae and gan algorithms is one of several other strategies for boosting picture resolution, however. Using these cutting-edge methods, we can produce fresh, high-resolution photographs. The traffic control agency can rapidly identify the faces or car numbers of the offender's thanks to these produced photos [1]–[3].

Our study aims to identify such violators who are overspeeding or without wearing a helmet. There are several strategies now in use to do this. Here, using cameras, we take the pictures and then, using a VAE GAN, a sort of neural network, we improve the area of interest, such as the person's face or the bike's licence plate. One of the difficulties the traffic control department has in the majority of cities is managing traffic and monitoring traffic violations. There is a serious issue with specifically monitoring traffic on flyovers. The flyovers are at least a kilometre or a half long. We cannot discover any traffic enforcement officers to monitor the traffic over this distance. Overspeeding is one of the main issues on flyovers since it may cause accidents and even premature death. Our initiative monitors these flyovers to stop these issues by taking pictures of people who are driving recklessly[4]–[6].

W and B are Fully Connected

As a result of the authors' simultaneous training of Dec as a VAE decoder and a GAN generator, VAE-GAN is a mix of VAE and GAN. In addition, learning similarity measurements are presented in the research as a potential first step for scaling neural network models to more intricate data distributions. VAE-GAN was also the first effort to teach encoder-decoder models unsupervised. This model's capacity to investigate visual features in the modernization of the latent space is another intriguing feature. VAE-GAN is used in a variety of application fields, as was mentioned at the blog's beginning.

Picture super-resolution (SR) methods are used to transform a low-resolution image into a high-resolution image. It has previously been shown that deep generative models, such as logistic

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regression and Generative Adversarial Networks (GANs), are quite good at modelling high-resolution images. Variational Autoencoder (VAE)-based models have long been criticised for their subpar generating capability, but recent advancements like VDVAE (very deep VAE) have shown that deep VAEs can now outperform current state-of-the-art models for high-resolution picture generation. In this study, we offer VDVAE-SR, a novel model that aims to boost picture super-resolution using the most current deep VAE techniques by using transfer learning on pre-trained models VDVAEs. Through qualitative and quantitative analyses, we demonstrate the suggested framework's viability.

Many techniques have developed throughout time to dramatically improve picture quality. The finished result is both upbeat and aesthetically beautiful. Discussing the neural network techniques used in signal processing to improve picture quality is the aim of this study. The study looks at the many neural network architectures that are available, especially the GANs architectural, as well as the alternative performance metrics related to image quality. This study also identifies areas for further study in the realm of image enhancement using computational models and GANs.

Auto Encoding Using a Learnt Similarity Metric beyond Pixels

This chapter describes an autoencoder that uses learned representations to more accurately analyse data space similarities. By fusing a variational autoencoder with a generative adversarial network, we may use learned feature representations in the GAN discriminator as the cornerstone for the VAE reconstruction aim. To ensure translation invariance and better depict the data distribution, we thus replace element-wise errors with feature-wise errors. It demonstrates that, when used on images of faces, our method beats VAEs using element-wise similarity metrics in terms of visual quality. It also shows that the method learns architecture in which high-level abstract visual characteristics, like wearing glasses, may be modified using simple mathematics.

The deep residual network SRResNet establishes a new standard on open benchmark datasets when tested using the commonly used PSNR method. They have highlighted some of the drawbacks of this PSNR-focused picture super-resolution and created SRGAN, which makes use of a GAN to add an adversarial loss to the content loss function. They verified that for high upscaling factors SRGAN reconstructions are much more photorealistic than reconstructions made utilising cutting-edge reference techniques and thorough MOS testing.

Bibliography

[1] S. Priya, M. Patel, and V. Patil, “Vehicle classification and traffic violation monitoring using convolutional neural networks with resnet and alexnet,” *Int. J. Adv. Sci. Technol.*, 2020.

[2] N.-A.- Alam, M. Ahsan, M. A. Based, and J. Haider, “Intelligent System for Vehicles Number Plate Detection and Recognition Using Convolutional Neural Networks,” *Technologies*, 2021, doi: 10.3390/technologies9010009.

[3] S. Zhang, M. Abdel-Aty, J. Yuan, and P. Li, “Prediction of Pedestrian Crossing Intentions at Intersections Based on Long Short-Term Memory Recurrent Neural Network,” *Transp. Res. Rec.*, 2020, doi: 10.1177/0361198120912422.

[4] Z. Charouh, A. Ezzouhri, M. Ghogho, and Z. Guennoun, “A Resource-Efficient CNN-Based Method for Moving Vehicle Detection,” *Sensors*, 2022, doi: 10.3390/s22031193.

[5] J. Wang, Y. Kong, and T. Fu, "Expressway crash risk prediction using back propagation neural network: A brief investigation on safety resilience," *Accid. Anal. Prev.*, 2019, doi: 10.1016/j.aap.2019.01.007.

[6] M. Shahverdy, M. Fathy, R. Berangi, and M. Sabokrou, "Driver behavior detection and classification using deep convolutional neural networks," *Expert Syst. Appl.*, 2020, doi: 10.1016/j.eswa.2020.113240.

CHAPTER 9

MODEL GENERATORS

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In this part, we will discuss generative models while avoiding the debates over discriminative vs. generative modelling and supervised vs. unsupervised learning paradigms.

Learning that is supervised vs. unsupervised

Predictive modelling is an example of a common machine learning issue where a model is used to produce a forecast. This calls for the creation of a training dataset, which is a collection of instances, or samples, each having input variables (X), and output class labels (y). A model is trained by providing examples of inputs, asking it to forecast outcomes, and then correcting the model such that the predicted outcomes match the actual outcomes more closely. This model adjustment is often referred to as supervised learning, or Classification and regression are examples of supervised learning tasks, whereas linear regression model and random forest are examples of supervised learning methods. There is another learning paradigm where the issue has no output variables and the model is simply given the input variables (X) (y).

The patterns in the incoming data are extracted or summarised to create a model. Since the model cannot anticipate anything, there is no need for adjustment. The descriptive or unsupervised learning strategy is the second primary form of machine learning. Primary inputs are provided in this case, and identifying "interesting patterns" in the data is the only objective. Since we are not instructed on what sorts of patterns to search for or what error metric to employ, this issue is significantly less well-defined [1]–[3].

Unsupervised learning is the term used to describe this kind of learning that does not get a correction. Clustering and generative modelling are examples of unsupervised learning issues, whereas K-means, as well as generative adversarial networks, are examples of unsupervised learning methods [4]–[6].

Generative Adversarial Networks

A generative model based on deep learning is called a generative adversarial network, or GAN. In a broader sense, GANs are a model architecture for training generative models, and deep learning models are often used in this architecture. Two sub-models make up the GAN model architecture: a generator model for creating new instances and a discriminator model for determining whether produced examples are genuine examples from the domain or fraudulent examples created by the generator model.

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- The generator is a model that is applied to the issue area to provide fresh, believable instances.
- Discriminator. Model for categorising samples as either genuine (from the domain) or fraudulent (generated).

A game-theoretic situation in which the generator network must compete with an attacker serves as the foundation for generative adversarial networks. Samples are generated directly by the generator network. The discriminator network, which is its rival, makes an effort to differentiate between samples taken from the training data and those taken from the generator.

The Generator Model

The generator model creates a sample in the domain using a fixed-length random vector as input. The generative process is seeded with a vector that is randomly selected from a Gaussian distribution. A compressed representation of the data distribution will be formed after training when points in this multidimensional vector space match points in the issue domain. Latent spaces, or vector spaces made up of latent variables, are what this particular vector space is known as. Latent variables, often known as hidden variables, are factors that are significant for a domain but cannot be seen directly.

Latent variables and latent spaces are often referred to as a projection or compression of a data distribution. In other words, a latent space offers a compression or high-level idea of the observed raw data, such as the distribution of the input data. In the case of GANs, the generator model assigns meaning to points in a predetermined latent space, allowing for the generation of fresh and distinctive output instances from the generator model by adding new points selected from the latent space as input. The generator model is preserved and utilised to produce fresh samples after training.

Discriminator Model

The discriminator model predicts a bitwise class label of genuine or fake based on an input sample from the domain (either actual or fabricated) (generated).

The training dataset contains the actual example. The generator model outputs the created examples. The discriminator is a typical classification paradigm that is well known. The discriminator model is abandoned after training since we are more interested in the generator. The generator may sometimes be put to new uses since it has mastered the art of successfully extracting features from examples in the issue area. The same or comparable input data may be utilised with any or all of the feature extraction layers in transfer learning applications.

Generic Adversarial Networks,

A min-max game between two players is built using Generative Adversarial Networks (GAN), a reliable network used for unsupervised machine learning. This involves setting up both players (networks) with their unique aims. The discriminator network (D) and the generator network (G) are the two participants (D). The first player (G) attempts to deceive the second player (D) by creating very realistic-looking real-world pictures from random latent vector z, while the second player (D) becomes better at diffusing the difference between actual and produced data. Because both networks have objective functions, i.e., D wants to increase its cost value and G wants to reduce its cost value, they both attempt to optimise themselves in the best manner to achieve their respective goals. Given that the generator and the discriminator are two distinct networks, the aforementioned equation demonstrates that there are two loss functions: log (D(x) for the discriminator network and log (1D (G(z))) for the generator network. Additionally, there are two optimizers for each network.

Bibliography

[1] C. E. Lavecchia, D. M. Espino, K. M. Moerman, K. M. Tse, D. Robinson, P. V. S. Lee, and D. E. T. Shepherd, "Lumbar model generator: A tool for the automated generation of a parametric scalable model of the lumbar spine," *J. R. Soc. Interface*, 2018, doi: 10.1098/rsif.2017.0829.

[2] I. Kamenarov and K. Grigorova, "Data model and software architecture for business process model generator," *Int. J. Informatics Vis.*, 2018, doi: 10.30630/joiv.2.4-2.176.

[3] A. Visoiu, "Structure Refinement for Vulnerability Estimation Models using Genetic Algorithm Based Model Generators," *Inform. Econ. J.*, 2009.

[4] D. Radošević and I. Magdalenić, "Introducing polymorphic features into a scripting model of generator," *J. Comput. Inf. Technol.*, 2011, doi: 10.2498/cit.1001739.

[5] Y. Zhou and C. Lee, "Evaluating the influence of a high-fidelity generator model on the gearbox dynamic responses of wind turbines," *J. Mech. Sci. Technol.*, 2021, doi: 10.1007/s12206-021-0501-8.

[6] Y. H. Lian and H. Van Landeghem, "Analysing the effects of Lean manufacturing using a value stream mapping-based simulation generator," *Int. J. Prod. Res.*, 2007, doi: 10.1080/00207540600791590.

CHAPTER 10

AUTOENCODER (AE)

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With the use of simple neural networks, the common form of generative model known as the autoencoder (AE) compresses large amounts of data into compact representations without suffering significant data loss. Encoder networks and decoder networks are both present in every AE. The encoder consists of many layers that take the input data and compress its dimensions to create a smaller representation [1]–[3]. A bottleneck is a low-quality or compressed representation of the input data. By using that bottleneck, the decoder attempts to reassemble the input data. The reconstruction loss is calculated by AE using encoder per-pixel differences. With the help of system-defined parameters, the encoder (g()) compresses the input data (x) in the basic architecture AE, and the decoder (f(()) decompresses the compressed data (z) [4]–[7].

Variational Autoencoder

Another popular likelihood-based generative model is the variational autoencoder (VAE). It consists of loss functions, a probabilistic encoder network, a probabilistic decoder network, or a generative network parameterized. Without suffering a significant loss in input data, the probabilistic decoder network (p(z|x)) reconstructs the input sample based on the discrete latent vector z used by the probabilistic encoder (q(z|x)) (also known as the latent variable generative model). The VAE's cost function is provided as follows:

Where x stands for the real data distribution and the parameterized distribution for the VAE probabilistic encoder-decoder structure. The reconstruction loss is represented in the first part of the equation, and the non-negative KL divergence between the real and approximate posterior is represented in the second part. A probabilistic encoder (q(z|x)) and a probabilistic decoder (p(z|x)) are both components of VAE. Variational Autoencoder, version Network of Generative Adversaries (VAEGAN)

A generative adversarial network is integrated with a variational autoencoder (VAE) (GAN) To better reflect the data distribution, feature-wise errors are used instead of element-wise errors. A VAE is made up of two networks that decode the latent representation back into the data space after encoding a data sample (x) to a latent representation (z).

A reconstruction error is specified in the GAN discriminator dislike as the VAE reconstruction (anticipated log-likelihood error term). To do this, a gaussian observation model for disk (x), which denotes the hidden representation of the lth layer of the discriminator and has identity covariance and mean disl(x), is added.

Convolutional Neural Networks and GANs

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Convolutional Neural Networks, or CNNs, are often used by GANs as the generator and discriminator models when working with picture data. The reason for this could be because the first description of the technique used CNNs and image data and was based on computer vision, as well as the remarkable advancements that have been made in recent years using CNNs more generally to produce state-of-the-art results on a variety of computer vision tasks, including object detection and face recognition.

When modelling picture data, a compressed representation of the collection of images or photos used to train the model is provided by the latent space, the generator's input. Additionally, it implies that the generator creates fresh pictures or photos, producing a result that model creators or users can quickly examine and evaluate.

The focus on computer vision applications with CNNs and the enormous improvements in the performance of GANs over other generative models, whether or not they are deep learning-based, may both be due to this fact, the ability to visually assess the quality of the generated output. This fact may be more important than others.

Contingent GANs

The GAN's usage for conditionally producing output is a significant extension. When the input, a random vector from the latent space, is given with (conditioned by) some extra input, the generative model may be trained to produce new instances from the input domain. When creating photos of humans, the extra input may be a class value, such as male or female, or it could be a digit, in the case of creating images of handwritten numbers. The discriminator is additionally conditioned, which means that it is given both the extra input and an input picture that is either genuine or phoney. The discriminator would then anticipate that the input would belong to that class in the case of a classification label type conditional input, which would train the generator to produce samples of that class to deceive the discriminator.

In this manner, samples from a domain of a certain kind may be produced using a conditional GAN. An additional step would be to condition the GAN models on a domain example, such as a picture. This enables the use of GANs for tasks like text-to-image or image-to-image translation. As a result, it is possible to use GANs for some of their more amazing applications, like style transfer, picture colourization, changing images from summer to winter or day to night, and so on.

Bibliography

[1] K. R. Shahi, P. Ghamisi, B. Rasti, P. Scheunders, and R. Gloaguen, “Unsupervised Data Fusion with Deeper Perspective: A Novel Multisensor Deep Clustering Algorithm,” *IEEE J. Sel. Top. Appl. Earth Obs. Remote Sens.*, 2022, doi: 10.1109/JSTARS.2021.3132856.

[2] X. Lu, W. Zhang, and J. Huang, “Exploiting Embedding Manifold of Autoencoders for Hyperspectral Anomaly Detection,” *IEEE Trans. Geosci. Remote Sens.*, 2020, doi: 10.1109/TGRS.2019.2944419.

[3] Z. Zhang, J. Yang, and Y. Du, “Deep Convolutional Generative Adversarial Network with Autoencoder for Semisupervised SAR Image Classification,” *IEEE Geosci. Remote Sens. Lett.*, 2022, doi: 10.1109/LGRS.2020.3018186.

[4] A. Khan, Z. Khan, P. Bhati, and M. E. Hussain, "Influence of Forward Head Posture on Cervicocephalic Kinesthesia and Electromyographic Activity of Neck Musculature in Asymptomatic Individuals," *J. Chiropr. Med.*, 2020, doi: 10.1016/j.jcm.2020.07.002.

[5] N. Hooda, R. Das, and N. Kumar, "Fusion of EEG and EMG signals for classification of unilateral foot movements," *Biomed. Signal Process. Control*, 2020, doi: 10.1016/j.bspc.2020.101990.

[6] S. Kimizuka, Y. Tanaka, S. Togo, Y. Jiang, and H. Yokoi, "Development of a Shoulder Disarticulation Prosthesis System Intuitively Controlled With the Trunk Surface Electromyogram," *Front. Neurorobot.*, 2020, doi: 10.3389/fnbot.2020.542033.

[7] R. J. Baggen *et al.*, "Age-related differences in muscle synergy organization during step ascent at different heights and directions," *Appl. Sci.*, 2020, doi: 10.3390/app10061987.

CHAPTER 11

ADVERSARIAL GENERATIVE NETWORKS

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Data augmentation is one of the many significant developments in the implementation of deep learning techniques in fields like computer vision. Better models are produced as a consequence of data augmentation, which also increases model skill and has a regularising impact that lowers generalisation error. To make sense of the input issue domain on which the model is trained, it generates additional, fabricated, but convincing instances. In the case of picture data, the procedures are basic and include cropping, flipping, zooming, and other straightforward transformations of the already-existing images in the training dataset [1]–[3].

A different, maybe more domain-specific way of data augmentation is offered by successful generative modelling. Data augmentation is, in reality, a simpler form of generative modelling, even though this is not often stated. Generative modelling offers a route to additional modelling training in difficult domains or areas with fewer data. In this use case, GANs have had a lot of success in fields like deep reinforcement learning. He specifically calls out GANs' excellent modelling of high-dimensional data, their handling of missing data, and their ability to provide multi-modal outputs or numerous plausible explanations [4]–[6].

For jobs requiring the creation of fresh instances, conditional GANs are perhaps the most persuasive use of GANs. Good fellow cites three key instances here:

- Super-Resolution of images.
- Creating high-resolution copies of the supplied photos.
- Producing art.
- The capacity to create original, creative drawings, paintings, and other things.
- Translation from image to image.
- The capacity to convert images between different climes, including summer and winter and other seasons.

The effectiveness of GANs is perhaps the most persuasive argument in favour of their widespread study, development, and use. Humans are unable to distinguish between photographs of real-world items, locations, and people and those created by GANs because they are so lifelike.

- **Pip and Python**

Ubuntu comes pre-installed with Python. Check that one of the following Python versions is already installed on your system by using the python -V command:

- **Python 3.3 and above**

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On Ubuntu, the pip or pip3 package management is often installed. Verify that pip or pip3 is implemented by running the pip -V or pip3 -V command. Version 8.1 or above of pip or pip3 is highly recommended. Issue the following command to instal or update to the most recent version of pip if Version 8.1 or later is not already installed.

An open-source software framework called TensorFlowTM uses data flow graphs to compute numerically. The graph's nodes stand in for mathematical processes, while its edges stand in for the multidimensional data arrays (tensors) that are sent between them. TensorFlow

- One of the following instructions to instal TensorFlow:
- Python 3.n; CPU support; $ pip3 instal TensorFlow (no GPU support)
- Python 3.n; GPU support; pip3 instal TensorFlow-GPU

PyTorch: Typically, PyTorch is used as either:

- A GPU-powered alternative to NumPy.
- A platform for deep learning research that offers the most flexibility and speed.
- Additional Information:
- A Tensor Library that is GPU-Ready

Tensors are provided by PyTorch, which significantly speeds up computation by allowing them to run on either the CPU or the GPU. For your scientific computing requirements, including slicing, indexing, arithmetic operations, linear algebra, and reductions, we provide a broad range of tensor routines. And they move quickly!

Tape-Based Auto grad in Dynamic Neural Networks

Using a tape recorder and playing back recordings, PyTorch provides a novel method for creating neural networks. The majority of frameworks feature a static view of the world, including TensorFlow, Theano, Caffe, and CNTK. Building a neural network requires repeatedly using the same structure. One must start again if one wants to change the way the network operates.

Reverse-mode auto-differentiation is a PyTorch approach that enables you to alter the behaviour of your network at will and without any lag or extra processing time. We were inspired by several research publications on the subject as well as present and previous works like torch-autograd, autograd, Chainer, etc. Although this method is not exclusive to PyTorch, it is one of its quickest applications to date. You benefit from the highest speed and adaptability for your illogical study.

Bibliography

[1] H. Zhang *et al.*, "StackGAN++: Realistic Image Synthesis with Stacked Generative Adversarial Networks," *IEEE Trans. Pattern Anal. Mach. Intell.*, 2019, doi: 10.1109/TPAMI.2018.2856256.

[2] X. Yi, E. Walia, and P. Babyn, "Generative adversarial network in medical imaging: A review," *Med. Image Anal.*, 2019, doi: 10.1016/j.media.2019.101552.

[3] Z. Wu, C. He, L. Yang, and F. Kuang, "Attentive evolutionary generative adversarial network," *Appl. Intell.*, 2021, doi: 10.1007/s10489-020-01917-8.

[4] A. Glickman, P. Nguyen, E. Shelton, D. A. Peterson, and B. D. Berman, "Basal ganglia and cerebellar circuits have distinct roles in blepharospasm," *Park. Relat. Disord.*, 2020, doi: 10.1016/j.parkreldis.2020.06.034.

[5] Y. Z. Yahya and Z. H. Al-Sawaff, "Design and modeling of an upper limb exoskeleton to assist elbow joint movement using surface emg signals," *Biomed. Eng. - Appl. Basis Commun.*, 2020, doi: 10.4015/S1016237220500064.

[6] S. Hazubski, H. Hoppe, and A. Otte, "Electrode-free visual prosthesis/exoskeleton control using augmented reality glasses in a first proof-of-technical-concept study," *Sci. Rep.*, 2020, doi: 10.1038/s41598-020-73250-6.

CHAPTER 12

EXPERIENCING THE IMPERATIVE

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PyTorch is meant to be simple to use, intuitive, and linear in concept. A line of code is run when it is executed. There isn't a worldview that is asynchronous. Understanding them is simple when you jump into a debugger or get error messages and stack traces. The precise location of your code's definition is shown by the stack trace. We hope that you never have to spend days debugging your code because the execution engines are asynchronous or opaque [1]–[4].

PyTorch is quick and lean, with little framework overhead. To increase performance, we include acceleration libraries from Intel MKL and NVIDIA (cuDNN, NCCL). Its neural network and Tensor backends on the CPU and GPU are sophisticated and have undergone extensive testing. As a result, PyTorch runs neural networks of all sizes pretty quickly.

When compared to Torch or some of the alternatives, PyTorch's memory utilisation is quite effective. For the GPU, we've created specialised memory allocators so that your deep-learning models will be as memory-efficient as possible. You are now able to train deeper learning models that are larger than previously [5]–[7].

Extensions Painless

It was intended to be simple and to use the least amount of abstraction possible while writing new neural network modules or interacting with PyTorch's Tensor API. Using the torch API or your preferred NumPy-based libraries, like SciPy, you may create new neural network layers in Python. We offer a straightforward extension API with a little boilerplate if you wish to develop your layers in C/C++. There is no need to create wrapper code. A tutorial and an illustration are available here.

Installer Programs

On our website, you may find commands to instal binaries using Conda or Pip wheels: https://pytorch.org/get-started/locally/

NVIDIA Jetson Systems

The L4T container is available here, and Python wheels for NVIDIA's Jetson Nano, Jetson TX2, and Jetson AGX Xavier are given there.

- They need JetPack 4.2 or later, and are maintained by @dusty-nv and @ptrblck.
- Requirements from Source
- Python 3.7 or later is required if you're installing from the source, and Python 3.7.6 or 3.8.1 or later is required for Linux.

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A compiler that supports C++14, such as clang Installing an Anaconda environment is strongly recommended. Regardless of your Linux distribution, you will get the high-quality BLAS library (MKL) and regulated dependent versions. Install the following if you wish to build with CUDA support (note that CUDA is not supported on macOS)

- At least NVIDIA CUDA 10.2
- NVIDIA cuDNN v7 or above
- Compiler CUDA-compatible
- For information on the different supported CUDA, CUDA driver, and NVIDIA hardware versions for cuDNN, see the cuDNN Support Matrix.
- Export USE CUDA=0 in the environment variable to turn off CUDA support.
- Setup.py may include other environment variables that might be helpful.

Instructions to instal PyTorch for Jetson Nano are available here if you are developing for NVIDIA's Jetson platforms (Jetson Nano, TX1, TX2, AGX Xavier). Install AMD ROCm 4.0 or above if you wish to build with ROCm support. Only Linux platforms are presently supported by ROCm.Export USE ROCM=0 in the environment variable if you wish to deactivate ROCm support. Setup may include other environmental variables that might be helpful.

Install Dependencies in py

Common conda instal typing extensions future six requests astunparse numpy ninja pyyaml setuptools cmake dataclasses Conda instal mkl mkl-include on LinuxOnly CUDA: Conda instal -c pytorch magma-cuda110 # or the magma-cuda* that corresponds to your CUDA version from https://anaconda.org/pytorch/repo may be used to provide LAPACK functionality for the GPU if necessary. Using MacOS Only instal this package on computers with Intel x86 processors. instal mkl mkl-include with conda.If you need torch.distributed, then add these packages. Install-pkg-config conda libuv

Linux installation of PyTorch.Run the following command first if you're building for AMD ROCm.Run this just if you're building for ROCm. Tools and build/build amd.py for Python Install export for PyTorch CONDA PREFIX:-"$(dirname $(which conda)).CMAKE PREFIX PATH=$" instal python setup.py. Be aware that if you are using Anaconda, you can get a linker errorTorch's csrc/stub.o in build/temp.linux-x86 64-3.7 is not recognised because it uses an unfamiliar file format collect2 error: programme 'g++' failed with exit status 1; ld returned 1 exit status error this is brought on by the system ld being shadowed by the Conda environment's ld. Use a more recent version of Python to address this problem. Python versions 3.7.6 and 3.8.1 and above are recommended. Apple Mac exports CMAKE PREFIX PATH= "$(dirname $(which conda))" is the CONDA PREFIX. Mac OS X Deployment Target 10.9, Clang, Clang++, and CC instal python setup.py

Select the appropriate Visual Studio version for Windows

It's advisable to use Visual Studio Version 16.8.5, which is the same as Pytorch CI's since there might sometimes be regressions in new versions of Visual Studio. Visual C++ BuildTools, which are included with Visual Studio Enterprise, Professional, or Community Editions, are used by

PyTorch CI. From https://visualstudio.microsoft.com/visual-cpp-build-tools, you can also instal the build tools. Visual Studio Code does not by default include the build tools. Please see Building on legacy code and CUDA CPU-only builds if you wish to compile legacy Python code. Conda activation python setup. In this mode, PyTorch calculations will execute on your CPU rather than your GPU.

instal py

Note on OpenMP: Intel OpenMP is the preferred OpenMP implementation (iomp). You must manually download the library and configure the build environment by changing CMAKE INCLUDE PATH and LIB in order to link against iomp. This setup guide serves as an example for both Intel OpenMP and MKL. Without these settings, Microsoft Visual C OpenMP runtime (vcomp) will be used instead of CMake.

Built on CUDA

In this mode, PyTorch will use CUDA to accelerate number crunching on your GPU crunching, To create Pytorch with CUDA, NVTX is required. NVTX is referred to as "Nsight Compute" in the CUDA distribution. To instal it on CUDA that is already installed Rerun the CUDA installation process and choose the appropriate checkbox. After installing Visual Studio, make sure CUDA with Nsight Compute is installed.

VS 2017 and 2019 as well as Ninja are now supported as CMake generators. The default generator will be Ninja if ninja.exe is found in PATH; else, VS 2017 or 2019 will be utilised.

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The newest MSVC will be used as the underlying toolchain if Ninja is chosen as the generator.

Magma, oneDNN, often known as MKLDNN or DNNL, and Sccache are a few other libraries that are frequently required. To instal these, please refer to the installation-helper.

For further information on setting up other environment variables, see the build pytorch.bat script.

Cmd

Prior to moving on, thoroughly read the material in the preceding section. Please execute the following script block if you wish to alter the underlying toolset utilised by Ninja and Visual Studio with CUDA. It will launch the "Visual Studio 2019 Developer Command Prompt" automatically. When using the Visual Studio generator, make sure you have CMake 3.12 or later.

Bibliography

[1] S. Wyatt, “Making Policies for Open Data: Experiencing the Technological Imperative in the Policy World,” *Science Technology and Human Values*. 2017. doi: 10.1177/0162243916687645.

[2] S. Vallesi, M. Tuson, A. Davies, and L. Wood, “Multimorbidity among people experiencing homelessness— insights from primary care data,” *Int. J. Environ. Res. Public Health*, 2021, doi: 10.3390/ijerph18126498.

[3] M. McCann Pineo and R. M. Schwartz, "Commentary on the coronavirus pandemic: Anticipating a fourth wave in the opioid epidemic.," *Psychol. Trauma Theory, Res. Pract. Policy*, 2020, doi: 10.1037/tra0000622.

[4] I. Bryce, "Responding to the accumulation of adverse childhood experiences in the wake of the COVID-19 pandemic: Implications for practice," *Children Australia*. 2020. doi: 10.1017/cha.2020.27.

[5] A. C. Graham, R. K. Mallinson, J. R. Krall, and S. L. Annan, "Sexual Assault, Campus Resource Use, and Psychological Distress in Undergraduate Women," *J. Interpers. Violence*, 2021, doi: 10.1177/0886260519884689.

[6] J. Vandewalle, D. Beeckman, A. Van Hecke, B. Debyser, E. Deproost, and S. Verhaeghe, "'Promoting and preserving safety and a life-oriented perspective': A qualitative study of nurses' interactions with patients experiencing suicidal ideation," *Int. J. Ment. Health Nurs.*, 2019, doi: 10.1111/inm.12623.

[7] Z. Alwi, R. D. A. Parmitasari, and A. Syariati, "An assessment on Islamic banking ethics through some salient points in the prophetic tradition," *Heliyon*. 2021. doi: 10.1016/j.heliyon.2021.e07103.

CHAPTER 13

LONG SHORT-TERM MEMORY

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One need for an intelligent transportation system is the prompt identification of traffic anomalies (ITS). Anomalies may have cascading repercussions that might cause traffic havoc if they are not addressed quickly. The following are typical instances of traffic anomalies: running red lights, speeding, colliding, and driving in the wrong lane. There hasn't been much research done on anomaly identification utilising video object trajectories and deep learning. In this research, we provide a colour gradient representation method for derived video-based vehicle trajectories. Using a hybrid CNN-VAE architecture, these trajectories are subsequently employed for categorization and anomaly detection at traffic intersections [1]–[3].

Trajectories are the most often employed characteristics for video-guided scene interpretation. A trajectory is a time series of data containing the positions of objects indexed in time. Because data length varies, classifying trajectories using neural networks is not an easy task. Finding a useful data representation is essential for the success of a time series signal classification. Classifiers using neural networks need inputs of a fixed size. For time series classification, CNN, Long Short Term Memory (LSTM), and Recurrent Neural Networks (RNN) have all been employed. Time series data, however, may range in duration. So, following preprocessing, such as making variable length data into fixed length data by padding or subsampling, the classification of the data may be used. Preprocessing is necessary if the trajectory length variation is significant.

Due to its contextual nature, video anomaly identification at traffic intersections is very difficult. For instance, only a select handful of the roads or directions are open for vehicle movement when light at a traffic intersection turns green. Any motion that defies direction is automatically regarded as anomalous, even if it may be perfectly typical in another situation. Time-series data has been classified using neural networks employing conventional characteristics including basis transform coding using wavelet and Fourier coefficients, time series mean and covariance, and symbolic representation. In addition, other models, such as Deep Belief Networks (DBN), have been used for the identification of human activity. The main applications of CNNs, on the other hand, include voice recognition, activity identification in movies, and picture categorization, among others [4]–[6].

A specific kind of recurrent neural network (RNN) that may be utilised to handle sequential/time series data is called a long short-term memory network (LSTM). A recurrent network linking LSTMs to CNNs has been suggested by the authors to perform action recognition and video categorization, respectively. The trained models for activity detection, picture description, and video description have been put. The work described connected CNNs and LSTMs under a hybrid deep learning architecture to attain state-of-the-art performance in video categorization.

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Action detection from video sequences has been accomplished using the Sequential Deep Trajectory Descriptor (DTD). Global Positioning System (GPS) trajectory categorization using Deep Neural Networks (DNN) has been used. For action detection in videos, dense feature trajectories have been employed. According to LIDAR (LIght Detection and Ranging), GPS, and inertial measurement unit (IMU) readings, the LSTM-based approach described classifies the trajectories of nearby cars at four-way junctions using fixed-size features.

Videos of people walking, running, leaping, and other actions have been classified using dense trajectory extraction from the neural network, etc. These techniques are unable to handle scenes with many actions. However, in a real-world setting, many objects may interact, leading to numerous actions occurring in the same scene. It might be difficult to train computational models for action identification when many different activities are going on. However, as DNNs can automatically detect edges from trajectories, object trajectories acquired using conventional approaches may be utilised for discovering motion patterns. The categorization and action recognition apps may then employ the trained/learned model.

In this study, we use a high-level representation called a colour gradient to encode video trajectories and incorporate the spatial and temporal information of the moving objects. A hybrid CNN-VAE architecture is then employed with the high-level representation for trajectory assessment and anomaly detection. Classifier with the ability to handle time series data with length changes has been favoured since accurate detection is the key to detecting abnormalities. Common neural network techniques need a set input size. As a result, different length trajectories cannot be employed directly in such classifiers. Conventional techniques, like the one, suggested, sample the fluctuating distance time series data to create fixed-size data.

Why a trajectory represented by a picture can't be used as an input to a classifier is the query. However, when mapped in 2D space, trajectories reflecting the movement of several objects between two places may seem visually identical. The temporal relationships between succeeding locations on a trajectory are not preserved in such representations. Comparable patterns yield similar colour gradients, as seen in the encoding of temporal data in the format of a colour gradient (red to violetSimilar to this, as seen in the trajectories with potential anomalies have distinct Spatio-temporal properties. We are inspired by this to suggest the following a high-level representation of object trajectories employing a gradient of colours to capture the spatiotemporal data of trajectories of various lengths. The identification of the trajectory classes using a semi-supervised labelling method based on modified Dirichlet Process Mixture Model (mDPMM) clustering.

Bibliography

[1] G. Van Houdt, C. Mosquera, and G. Nápoles, "A review on the long short-term memory model," *Artif. Intell. Rev.*, 2020, doi: 10.1007/s10462-020-09838-1.

[2] S. Hizlisoy, S. Yildirim, and Z. Tufekci, "Music emotion recognition using convolutional long short term memory deep neural networks," *Eng. Sci. Technol. an Int. J.*, 2021, doi: 10.1016/j.jestch.2020.10.009.

[3] D. Fister, M. Perc, and T. Jagrič, "Two robust long short-term memory frameworks for trading stocks," *Appl. Intell.*, 2021, doi: 10.1007/s10489-021-02249-x.

[4] G. Mao, M. Wang, J. Liu, Z. Wang, K. Wang, Y. Meng, R. Zhong, H. Wang, and Y. Li, "Comprehensive comparison of artificial neural networks and long short-term memory networks for rainfall-runoff simulation," *Phys. Chem. Earth*, 2021, doi: 10.1016/j.pce.2021.103026.

[5] B. Gao, R. R. Wang, C. Lin, X. Guo, B. Liu, and W. Zhang, "TBM penetration rate prediction based on the long short-term memory neural network," *Undergr. Sp.*, 2021, doi: 10.1016/j.undsp.2020.01.003.

[6] P. Ma, B. Jiang, Z. Lu, N. Li, and Z. Jiang, "Cybersecurity named entity recognition using bidirectional long short-term memory with conditional random fields," *Tsinghua Sci. Technol.*, 2021, doi: 10.26599/TST.2019.9010033.

CHAPTER 14

TRANSMISSION CABLES

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A parallel signal may be sent more quickly than a serial one. This is because each transmitted bit has its electrical interface, necessitating the use of separate cable television for each bit of the placement code. Multi-core transmission cables, which are expensive and difficult to install over lengthy distances, are required for encoders with very high resolutions. Whenever feasible, identical connections are dropped in favour of serial linkages for this purpose. Although signal transmission in combination is slower than in parallel, it also uses fewer wires, which reduces costs and makes installation easier. One of the most popular nowadays is absolute systems with serial computerized user interfaces like SSI, ISI, EnDat, BiSS, and Hiperface [1]–[3].

Encoders with network outputs that operate directly with a commercial network like Application software or PROFINET are also available on the market. In this instance, the communication protocol is used to send the code signal, which identifies the location, to the controller as a whole. Encoders are increasingly frequently used tools in both business and everyday household gadgets. Here are a few examples of how encoders are employed: IN printing applications, the printhead is prompted by feedback from the encoder to generate a mark at a particular location. In elevators, encoders alert the controller to the proper setting when the elevator reaches the desired level. Additionally, encoder feedback makes sure that the elevator doors are open when the proper level is reached. You wouldn't be able to go to a different level without the encoder; you could only enter or depart the elevator.

The output of incremental encoders is two square waves, each of which represents an iteration of rotation. Typically, an LED emits light via a convex lens that concentrates it into a parallel beam; this beam then goes through a grid diaphragm and is divided into two 90° out of phase beams. A disc transmits light from the A and B channels onto the photo-voltaic or optoelectronic array. The segments of the transparent and opaque disc rotate in a light-dark pattern.

A photodiode array and decoding circuitry read and interpret this pattern; beams A and B are each received by a different diode and turned into two square-wave signals quadrature output, which is the output that is 90 degrees out of phase. The signal is then transmitted into a processor, which analyses it to extract details like the number of pulses, direction, speed, and others. The third broadcaster with a specific channel slot or referent that is used to zero or home the device is another option for incremental encoders. An incremental sine-wave encoder, as an alternative, generates a square quadrature voltage waveform (sine and cosine). Any number of resolution levels may be produced through arctangent operating.

A disc with several distinct tracks and several detectors is used in an absolute encoder. The disc generates Gray code output, which differs each subsequent value by one bit (unlike straight binary) and is named after Bell Labs scientist Frank Gray. Since the encoder can only halt in between transitions, the greatest allowable mistake is just 0.5 bit. Even if the encoder went out briefly, this data is still accessible.

Multiturn optical encoders extend absolute tracking by timing movement across several revolutions. The main gear in geared systems meshes with an encoder shaft to move a secondary gear, and so forth: The encoder electronics and sensors track the rotation of each gear, which is an etched disc. The encoder aggregates the output of all the discs to determine the total frequency of shaft turns.

On automated assembly lines, encoders provide feedback to robotics about motion and positioning. In precise servo systems, the PLC uses the encoder signal to control the speed and positioning of machine components. In cranes, such as a crane, encoders positioned on the electric motor shaft give placement feedback so you know when to lift or launch the tonnes. For an automobile manufacturing line, for example, encoders supply automated welding arms with information about the location in which they are to bond [4]–[6].

The encoder provides the filling equipment with information about the location of the containers in applications where jars or containers are filled. The control procedure is the same in every application that uses an encoder: the encoder provides electrical pulses to the control system, which subsequently transmits signals to the device or application to carry out a specified function. In a closed circuit, control is achieved by feedback.

Bibliography

[1] H. M. Song, J. Woo, and H. K. Kim, "In-vehicle network intrusion detection using deep convolutional neural network," *Veh. Commun.*, 2020, doi: 10.1016/j.vehcom.2019.100198.

[2] X. Sui, Q. Wu, J. Liu, Q. Chen, and G. Gu, "A review of optical neural networks," *IEEE Access*, 2020, doi: 10.1109/ACCESS.2020.2987333.

[3] M. S. Advani, A. M. Saxe, and H. Sompolinsky, "High-dimensional dynamics of generalization error in neural networks," *Neural Networks*, 2020, doi: 10.1016/j.neunet.2020.08.022.

[4] P. Zurn and D. S. Bassett, "Network architectures supporting learnability," *Philosophical Transactions of the Royal Society B: Biological Sciences*. 2020. doi: 10.1098/rstb.2019.0323.

[5] M. Dennissen, Y. Benschop, and M. van den Brink, "Rethinking Diversity Management: An Intersectional Analysis of Diversity Networks," *Organ. Stud.*, 2020, doi: 10.1177/0170840618800103.

[6] I. Hertrich, S. Dietrich, and H. Ackermann, "The Margins of the Language Network in the Brain," *Frontiers in Communication*. 2020. doi: 10.3389/fcomm.2020.519955.

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