Automated Shopping Environment using IOT

A project report submitted in complete fulfillment of
the requirements for the degree of

Bachelor of Engineering

by

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April 28, 2018

This work is dedicated to my family.

I am very thankful for their motivation and support.

Internal Approval Sheet

CERTIFICATE

This is to certify that the project entitled **"Automated Shopping Environment using IOT"** is a bonafide work of **Peter Emil P(7338), Shetty Pratik Umesh(7352), Benz Murzello(7328)** submitted to the University of Mumbai in partial fulfillment of the requirement for the award of the degree of **Bachelor of Engineering** in **Electronics**

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Supervisor/Guide

(Name and sign)	(Name and sign)
Head of Department	Principal

Approval Sheet

Project Report Approval

This project report entitled by **Automated Shopping Environment using IOT** by **Peter Emil P, Shetty Pratik Umesh, Benz Murzello** is approved for the degree of Bachelor of Engineering

Examiners

1.__________________________

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Declaration

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

Peter Emil P (Roll No. 7338) **(sign)**________________
Shetty Pratik Umesh (Roll No. 7352) **(sign)**________________
Benz Murzello (Roll No. 7328) **(sign)**________________

Date: April 28, 2018

Abstract

This project aims to design an automated shopping environment.The project consists of two modules- smart drawer and automated trolley.The smart drawer will update the database with the items and quantity of each item present in the drawer.A webpage will display the items that are present in the drawer.Order to buy certain items is placed online through a webpage and this list of items to be purchased is send to the automated trolley in the shop.The trolley moves from one stop to another stop where the items to be purchased are placed. Hence a single trolley will contain all the items ordered by a customer ready for home delivery. The bill for the items purchased will be generated online.

Acknowledgments

We have great pleasure in presenting the report on **"Automated Shopping Environment using IOT"**. I take this opportunity to express my sincere thanks towards the guide Prof.Vaibhav Godbole, C.R.C.E, Bandra (W), Mumbai, for providing the technical guidelines, and the suggestions regarding the line of this work. We enjoyed discussing the work progress with him during our visits to department.

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Date: April 28, 2018

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EPC Electronic Product Code. 4

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Chapter 1

Introduction

This decade has seen various technical innovations like big data, Internet of things,etc. coming into existence. These innovations have changed the way in which we see and perceive normal things in our day to day lives.Now the coffee maker in our house can make coffee depending on our needs without even requiring us to instruct it.It will automatically sense that we need coffee at a particular hour of the day from the data accumulated about the pattern in which we drink coffee. Even one can easily predict when a machine in an industrial process will fail and why it will fail well in advance ,hence helping us to prevent the losses one would incur because of such a malfunction.These things all are possible only because of the connectivity of these devices to each other and to a monitoring system.This enables us to collect data from these devices which can be analysed and put to use in the future. Even we are able to control a system by sitting in a remote place using a mobile application.

We have used this technology in our project.The smart drawer keeps a track of the items present in the drawer and enables us to predict the shopping list for the customer. By sitting at the home itself the customer can buy things by ordering it online. The automated system collects the items that are enlisted in the shopping list,sent to it over the internet.Hence designing such a automated shopping environment has various benefits.

1.1 Motivation

Studies have shown that this innovation can reduce labour by at least 80 percent.Implementing this in warehouses will also reduce warehouse space by upto 30-40 percent.Hence saving a lot of money. Studies have shown that on average, shoppers visit 3.4 times per month and stay for 1 hour and 24 minutes. It turns out that about 4.42 hours per month is spent inside a shopping mart by customers. This much amount of time can be reduced to a great extent using this innovation. The user does not have to worry about the items he has to buy and he does not have to go and spend a lot of time shopping things in a mart. All the user has to do is confirm his shopping list online and his order is delivered at his doorstep without efforts. Though the system has significant amount of money to be invested for its initial setup, but in the long run it saves a lot of money in the form of labour and infrastructure and also time.

1.2 Objectives

This project aims to design a smart drawer and an automated shopping environment wherein the list of items to be bought are generated automatically by the system and the list after being approved by the customer via the webpage is send to the trolley in the shopping mart.A trolley is assigned to each customer.This will allow the users to shop with ease and keep track of the items that are required.The following main objectives of this project are [1]

1. Develop an embedded system that will detect an item placed in/out of the drawer and send this data to a server.
2. Develop a Client-Server system which will keep maintain a database of the items in the drawer.
3. Develop a Client-Server system which will send shopping list to an automated trolley.
4. Develop an automated trolley which will automatically go and halt at the required place where the items are stored.

Chapter 2

Literature Review

In the above chapter we have highlighted the main part of the project and about its importance. This project is the implementation of many project ideas taken from many technical papers available on the internet.

2.1 A novel sensing method for automatic guidance of trolley vehicles based on digital beam forming radar

In this paper, a radar based measurement technique for detection of overhead contact lines is introduced. The detection capability of overhead contact lines with the presented DBF radar system is successfully demonstrated by measurements of two metal bars. By using the following ideas we have implemented the laser sensors in our project which has been used as the critical component in our line following bot.The bot in our project is the device on which the trolley is mounted and has the stops marked with the black lines where the items need to be picked [2].

2.2 Automatic Human Guided Shopping Trolley with Smart Shopping System

A line following portable robot is installed under the trolley to lead the users to the items location that they plan to purchase in the supermarket. This paper presents the hardware and software design of the portable robot. The result of the testing on the used sensors like ultrasonic and line sensors are presented. Lastly, the graphical user interface of our website is used to update the database has been inspired.Arduino Uno is used in both the drawer and the trolley [3].

2.3 Fabrication of Automated Electronic Trolley

In the fabrication of the automated trolley, two IR sensors are used.Passive infrared sensors (PIR sensors) are electronic devise which measure infrared light radiating from objects in the field of view.All objects emit infrared radiation. This radiation is invisible to the human eye but can be detected by electronic devices designed for such a purpose [4].

2.4 Automatic Shopping Trolley using Sensors

Here in a basic RFID system, tags are attached to all the items that are to be tracked. These tags are made from a tiny tag chips,sometimes called as an integrated circuit(IC) that is connected to an antenna that can be built into many different kinds of tags including apparel hang tags, labels and security tags as well as a wide variety of industrial asset tags . The tag chip contains memory which stores the product's electronic product code (EPC) and other variable information so that it can be read and tracked by RFID readers anywhere [5].

Chapter 3

Project Overview

In today's modern era the main aim if the technology is to reduce human effort by making use of the technology.In this following project we are interfacing our trolley and the smart drawer with the web page which together execute the aim of the smart shopping environment.Following is the block diagram of the project:

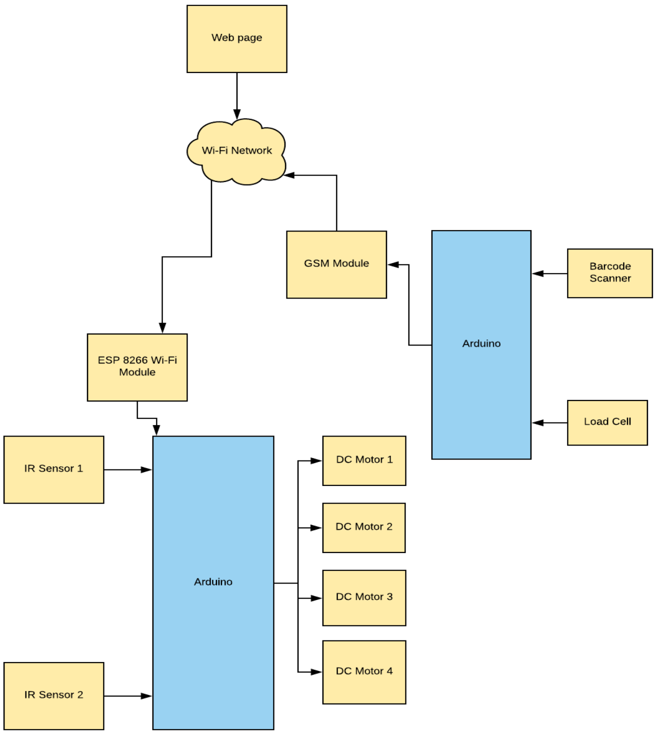


Figure 3.1: Basic Block diagram of the System

3.1 Smart Drawer

Whenever an item is placed in or taken out of the drawer, the user has to scan the barcode of item using a scanner.If the item is placed then the load cell will detect increase in weight and a character corresponding to the increase in weight would be sent to esp8266 wifi module.

If item is removed then the load cell will detect decrease in weight and a character corresponding to decrease will be serially sent to wifi module.The wifi module will send the character to the server and in turn the quantity of that item would be updated in the database and hence displayed on a webpage.

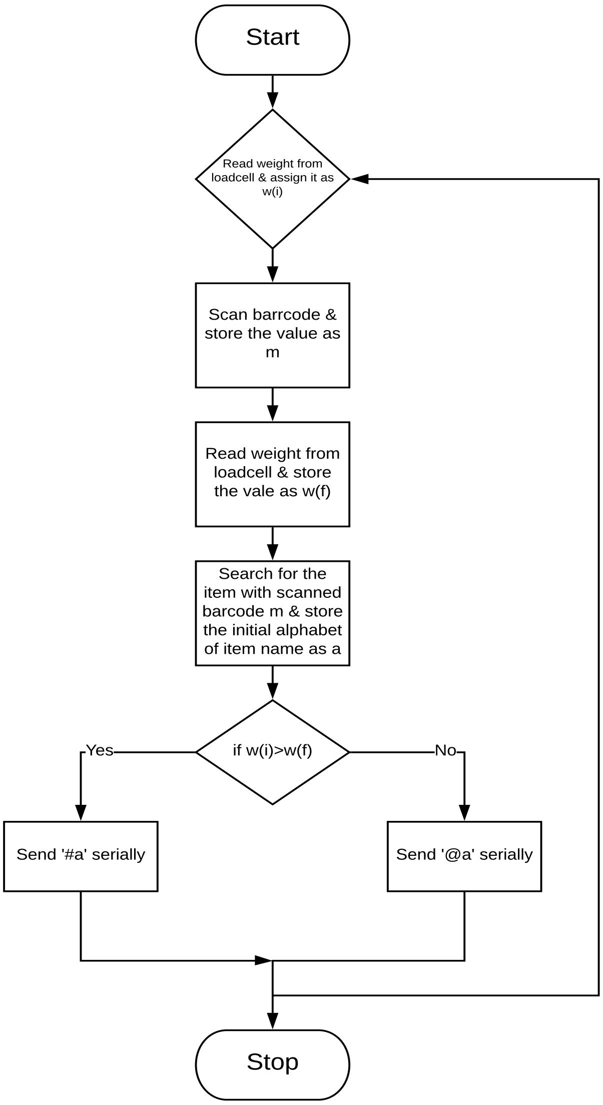

Start
Read weight from loadcell & assign it as w(i)
Scan barrcode & store the value as m
Read weight from loadcell & store the vale as w(f)
Search for the item with scanned barcode m & store the initial alphabet of item name as a
if w(i)>w(f)
Yes
No
Send '#a' serially
Send '@a' serially
Stop

Figure 3.2: Flowchart of Smart Drawer

3.2 Automated trolley

[6] The trolley receives the shopping list as a sequence of characters indicating the item and the amount of item required from the server.A black line is marked at places where an item is placed. The trolley moves from one stop to the other depending on shopping list been sent to it.The stops where the trolley has to stop depends on the items to be shopped. The time for which trolley halts at a stop depends on the quantity specified. Once the trolley has connected all item it returns back to the starting line [7].

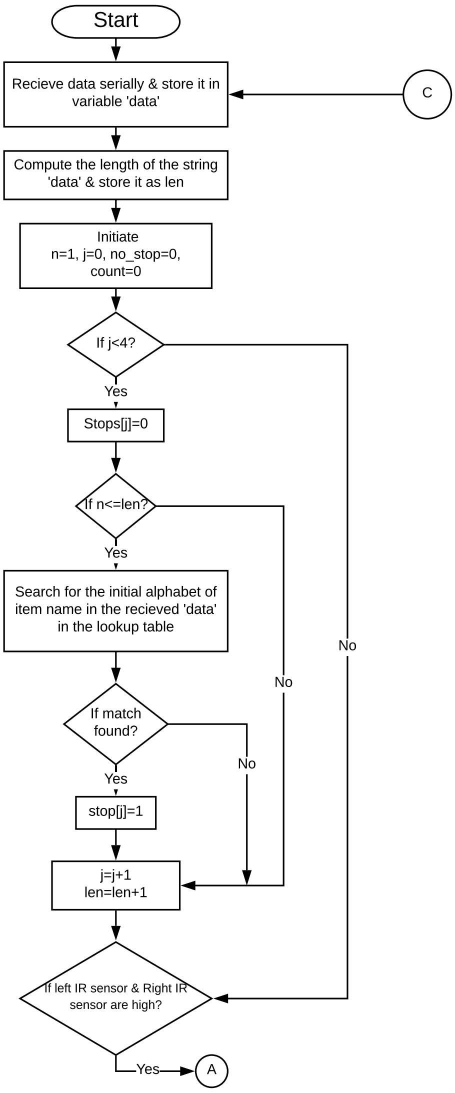

Start
Recieve data serially & store it in variable 'data'
C
Compute the length of the string 'data' & store it as len
Initiate
n=1, j=0, no_stop=0, count=0
If j<4?
Yes
Stops[j]=0
If n<=len?
Yes
Search for the initial alphabet of item name in the recieved 'data' in the lookup table
No
No
If match found?
No
Yes
stop[j]=1
j=j+1
len=len+1
If left IR sensor & Right IR sensor are high?
Yes
A

Figure 3.3: Flowchart of Automated Trolley I

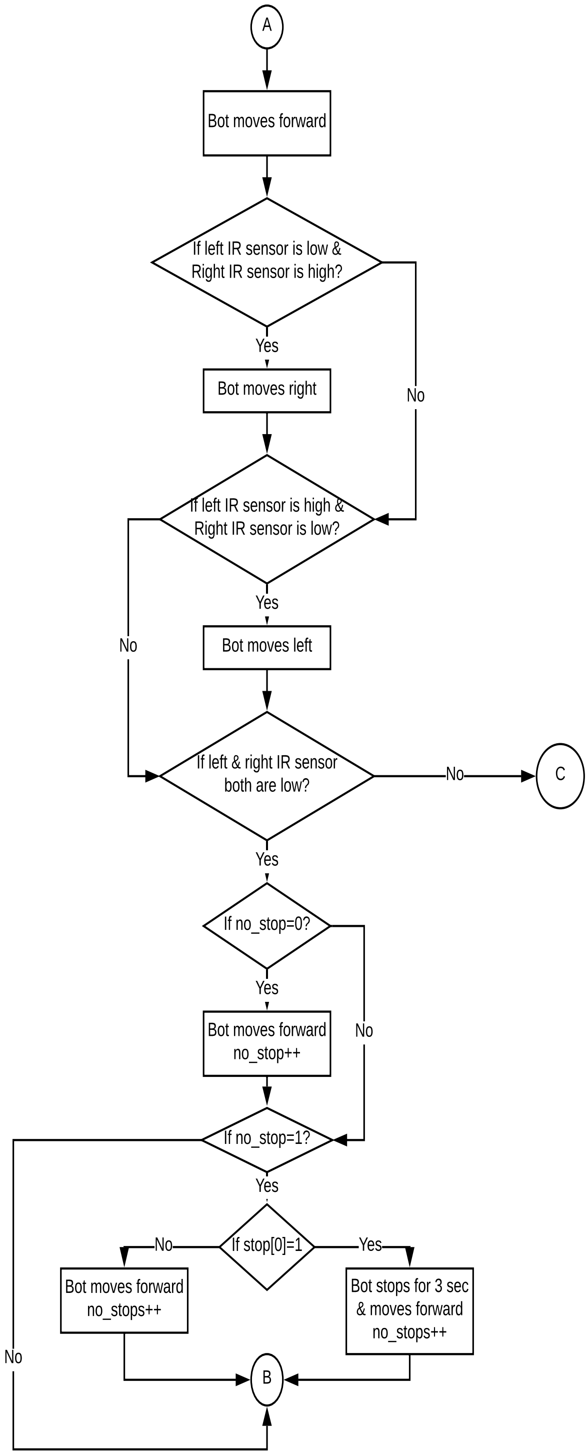

A
Bot moves forward
If left IR sensor is low & Right IR sensor is high?
Yes
No
Bot moves right
If left IR sensor is high & Right IR sensor is low?
Yes
No
Bot moves left
If left & right IR sensor both are low?
No
C
Yes
If no_stop=0?
Yes
No
Bot moves forward no_stop++
If no_stop=1?
Yes
No
If stop[0]=1
No
Yes
Bot moves forward no_stops++
Bot stops for 3 sec & moves forward no_stops++
B

Figure 3.4: Flowchart of Automated Trolley II

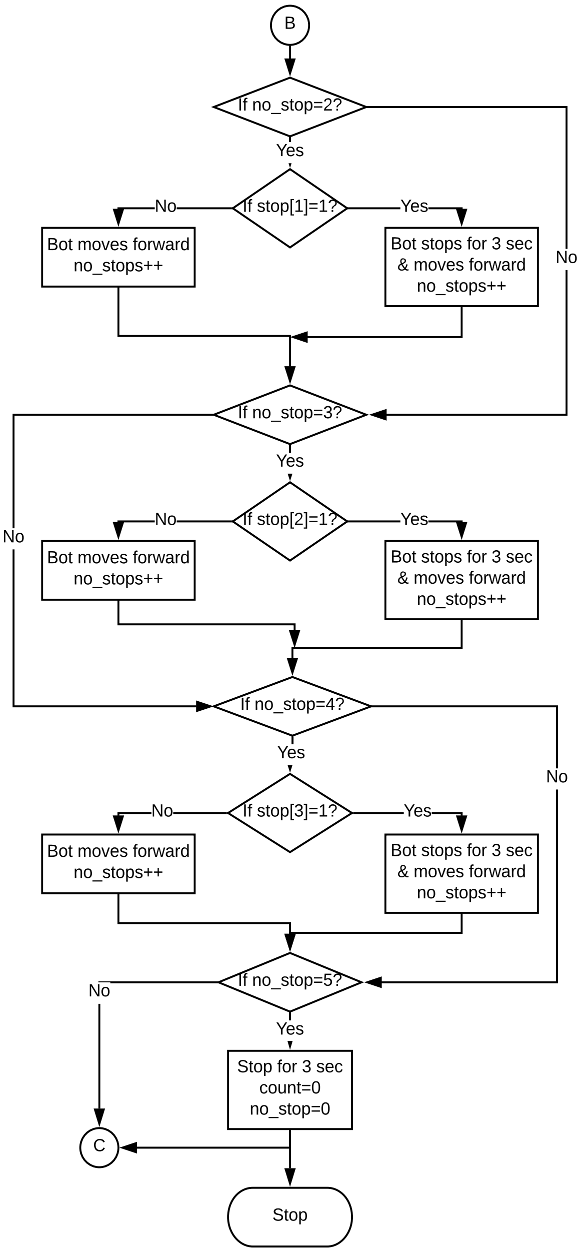


Figure 3.5: Flowchart of Automated Trolley III

3.3 Webpage

A webpage is developed where the items along with their quantities are displayed.Once the threshold for each item is crossed,a notification is generated urging the user to shop.The webpage provides options to select the items required along with their quantity.Once it is submitted this list is send to the WiFi module.

Chapter 4

Hardware Implementation

4.1 ESP8266

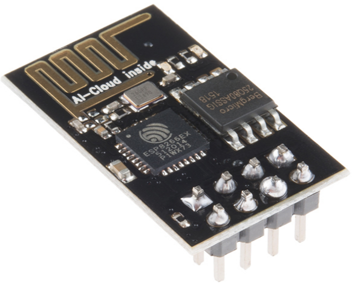


Figure 4.1: ESP8266

The ESP8266 Wi-Fi Module is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your Wi-Fi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor.Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much Wi-Fi-ability as a Wi-Fi Shield offers (and that's just out of the box)! The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community.

This module has a powerful enough on-board processing and storage capability that allows it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. Its high degree of on-chip integration allows for minimal external circuitry, including the front-end module, is designed to occupy minimal PCB area. The ESP8266 supports APSD for VoIP applications and Bluetooth co-existence interfaces.

4.1.1 WiFi Protocols

1. 802.11 b/g/n support
2. 2 x Wi-Fi interface, supports infrastructure BSS Station mode / P2P mode / SoftAP mode support
3. Hardware accelerators for CCMP (CBC-MAC, counter mode), TKIP (MIC, RC4), WAPI (SMS4), WEP (RC4), CRC
4. 802.11n support (2.4 GHz)
5. Supports MIMO 1x1 and 2x1, STBC, and 0.4 s guard interval
6. WMM
7. UMA compliant and certified
8. Antenna diversity and selection (software managed hardware)
9. Configurable packet traffic arbitration (PTA) with dedicated slave processor based design provides flexible and exact timing Bluetooth co-existence support for a wide range of Bluetooth Chip vendor.

4.1.2 Features

1. Processor: L106 32-bit RISC microprocessor core based on the Tensilica Xtensa Diamond Standard 106Micro running at 80 MHz
2. Memory:
   (a) 32 KiB instruction RAM
   (b) 2 KmiB instruction cache RAM
   (c) 80 KiB user data RAM
3. 16 KiB ETS system data RAM
4. External QSPI flash: up to 16 MiB is supported (512 KiB to 4 MiB typically included)

4.1.3 Functional Block Diagram Of ESP8266

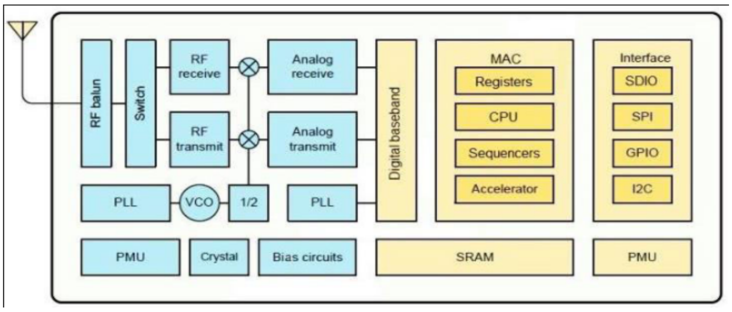


Figure 4.2: Block Diagram Of ESP8266

1. CPU

   The ESP8266EX integrates a Tensilica L106 32-bit RISC processor, which achieves extralow power consumption and reaches a maximum clock speed of 160 MHz. The Real-Time Operating System (RTOS) and Wi-Fi stack allow 80available for user application programming and development. The CPU includes the interfaces as below.

   (a) Programmable RAM/ROM interfaces (iBus), which can be connected with memory controller, and can also be used to visit flash.

   (b) Data RAM interface (dBus), which can connected with memory controller.

   (c) AHB interface which can be used to visit the register.

2. Memory

   ESP8266EX Wi-Fi SoC integrates memory controller and memory units including SRAM and ROM. MCU can access the memory units through iBus, dBus, and AHB interfaces. All memory units can be accessed upon request, while a memory arbiter will decide the running sequence according to the time when these requests are received by the processor.According to our current version of SDK, SRAM space available to users is assigned as below.

   (a) RAM size $<$ 50 kB, that is, when ESP8266EX is working under the Station mode andconnects to the router, programmable space accessible in heap + data section is around 50 kB.

   (b) There is no programmable ROM in the SoC, therefore, user program must be stored in an external SPI flash.

4.1.4 Pin Connections Of ESP8266

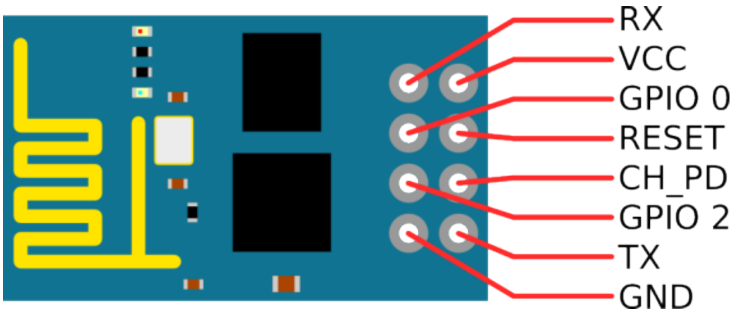


Figure 4.3: Pin Connections Of ESP8266

4.1.5 Applications Of ESP8266

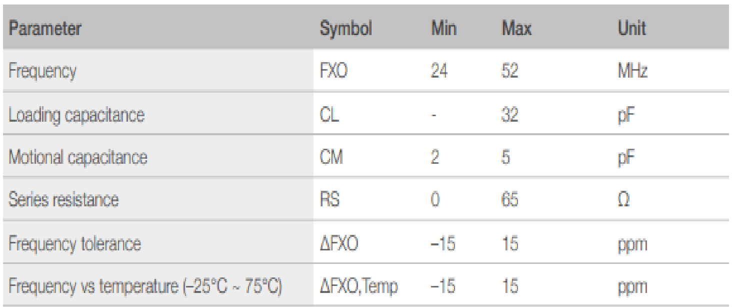
1. Home appliances
2. Home automation
3. Smart plugs and lights
4. Mesh network
5. Industrial wireless control
6. Baby monitors
7. IP cameras
8. Sensor networks
9. Wearable electronics
10. Wi-Fi location-aware devices
11. Security ID tags
12. Wi-Fi position system beacons

4.1.6 WiFi

ESP8266EX implements TCP/IP, the full 802.11 b/g/n WLAN MAC protocol and Wi-Fi Direct specification. It supports not only basic service set (BSS) operations under the distributed control function (DCF) but also P2P group operation compliant with the latest Wi-Fi P2P protocol. Low level protocol functions are handled automatically by ESP8266EX.

1. RTS/CTS
2. acknowledgement
3. fragmentation and defragmentation
4. aggregation
5. frame encapsulation (802.11h/RFC 1042)
6. automatic beacon monitoring / scanning, and
7. P2P Wi-Fi direct

4.1.7 Clock



Parameter	Symbol	Min	Max	Unit
Frequency	FXO	24	52	MHz
Loading capacitance	CL	-	32	pF
Motional capacitance	CM	2	5	pF
Series resistance	RS	0	65	Ω
Frequency tolerance	ΔFXO	−15	15	ppm
Frequency vs temperature (−25°C ~ 75°C)	ΔFXO,Temp	−15	15	ppm

Figure 4.4: High Frequency Clock Specifications

1. High Frequency Clock
   The high frequency clock on ESP8266EX is used to drive both transmit and receive mixers. The crystal frequency ranges from 24 MHz to 52 MHz.The internal calibration inside the crystal oscillator ensures that a wide range of crystals can be used, nevertheless the quality of the crystal is still a factor to consider to have reasonable phase noise and good Wi-Fi sensitivity. Refer to Table to measure the frequency offset.

4.1.8 Power Management

ESP8266EX is designed with advanced power management technologies and intended for mobile devices, wearable electronics and the Internet of Things applications.The low-power architecture operates in three modes: active mode, sleep mode and Deepsleep mode. ESP8266EX consumes about 20 ÎijA of power in Deep-sleep mode (with RTC clock still running) and less than 1.0 mA (DTIM=3) or less than 0.6 mA (DTIM=10) to stay connected to the access point.

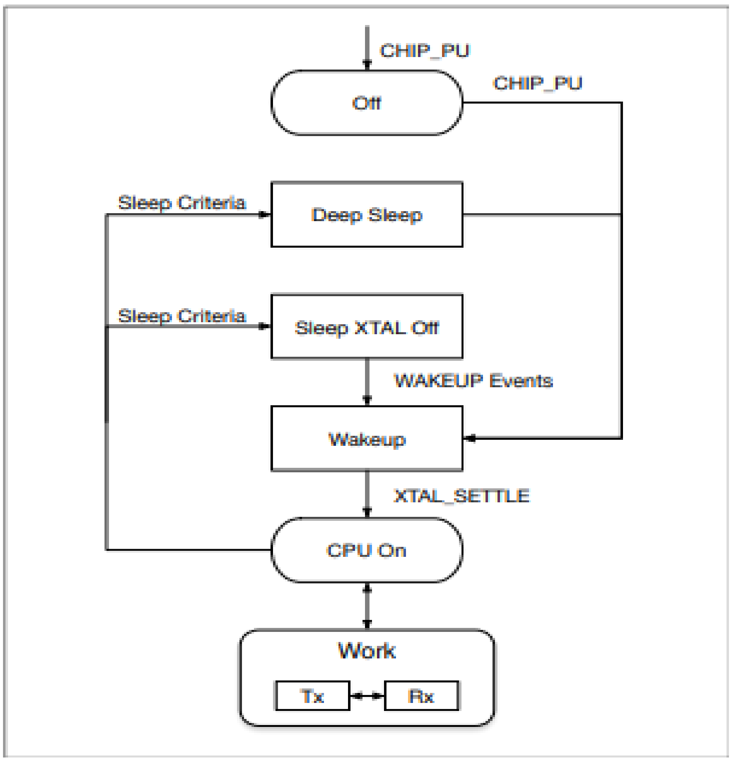


Figure 4.5: Power Management

1. Off: CHIP PU pin is low. The RTC is disabled. All registers are cleared.
2. Deep-sleep: Only RTC is powered on-the rest of the chip is powered off. Recovery memory of RTC can save basic Wi-Fi connection information.
3. Sleep: Only the RTC is operating. The crystal oscillator is disabled. Any wake-up events (MAC, host, RTC timer, external interrupts) will put the chip into the wakeup mode.
4. Wakeup: In this state, the system switches from the sleep states to the PWR mode.The crystal oscillator and PLLs are enabled.

5. On: The high speed clock is able to operate and sent to each block enabled by the clock control register. Lower level clock gating is implemented at the block level, including the CPU, which can be gated off using the WAITI instruction while the system is on.

4.1.9 Radio

ESP8266EX radio consists of the following blocks.

1. 2.4 GHz receiver
2. 2.4 GHz transmitter
3. High speed clock generators and crystal oscillator
4. Real time clock
5. Bias and regulators
6. Power management

4.2 Barcode Scanner

Figure 4.6: Barcode Scanner

A barcode reader (or barcode scanner) is an electronic device that can read and output printed barcodes to a computer. Like a flatbed scanner, it consists of a light source, a lens and a light sensor translating optical impulses into electrical ones. Additionally, nearly all barcode readers contain decoder circuitry analyzing the barcode 39;s image data provided by the sensor and sending the barcode 39;s content to the scanner 39;s output port.

Pen-type Barcode readers consist of a light source and photodiode that are placed next to each other in the tip of a pen or wand. To read a bar code, the person holding the pen must move the tip of it across the bars at a relatively uniform speed. The photodiode measures the intensity of the light reflected back from the light source as the tip crosses each bar and space in the printed code. The photodiode generates a waveform that is used to measure the widths of the bars and spaces in the bar code. Dark bars in the bar code absorb light and white spaces reflect light so that the voltage waveform generated by the photodiode is a representation of the bar and space pattern in the bar code. This waveform is decoded by the scanner in a manner similar to the way Morse code dots and dashes are decoded.

Laser Barcode scanners work the same way as pen type readers except that they use a laser beam as the light source and typically employ either a reciprocating mirror or a rotating prism to scan the laser beam back and forth across the bar code. As with the pen type reader, a photo-diode is used to measure the intensity of the light reflected back from the bar code. In both pen readers and laser scanners, the light emitted by the reader is rapidly varied in brightness with a data pattern and the photo-diode receive circuitry is designed to detect only signals with the same modulated pattern.

4.2.1 Types of barcode scanners

1. Pen-type Scanners

   Pen-type readers consist of a ight source and photodiode that are placed next to each other in the tip of a pen or wand. To read a bar code, the person holding the pen must move the tip of it across the bars at a relatively uniform speed. The photodiode measures the intensity of the light reflected back from the light source as the tip crosses each bar and space in the printed code. The photodiode generates a waveform that is used to measure the widths of the bars and spaces in the bar code. Dark bars in the bar code absorb light and white spaces reflect light so that the voltage waveform generated by the photodiode is a representation of the bar and space pattern in the bar code. This waveform is decoded by the scanner in a manner similar to the way Morse code dots and dashes are decoded.

2. Laser Scanners

   Laser scanners work the same way as pen type readers except that they use a laser beam as the light source and typically employ either a reciprocating mirror or a rotating prism to scan the laser beam back and forth across the bar code. As with the pen type reader, a photo-diode is used to measure the intensity of the light reflected back from the bar code. In both pen readers and laser scanners, the light emitted by the reader is rapidly varied in brightness with a data pattern and the photo-diode receive circuitry is designed to detect only signals with the same modulated pattern.

3. CCD readers (also known as LED scanners)

   CCD readers use an array of hundreds of tiny light sensors lined up in a row in the head of the reader. Each sensor measures the intensity of the light immediately in front of it. Each individual light sensor in the CCD reader is extremely small and because there are hundreds of sensors lined up in a row, a voltage pattern identical to the pattern in a bar code is generated in the reader by sequentially measuring the voltages across each sensor in the row. The important difference between a CCD reader and a pen or laser scanner is that the CCD reader is measuring emitted ambient light from the bar code whereas pen or laser scanners are measuring reflected light of a specific frequency originating from the scanner itself.

4. Camera Based Readers

   Two-dimensional imaging scanners are a newer type of bar code reader. They use a camera and image processing techniques to decode the bar code.

   Video camera readers use small video cameras with the same CCD technology as in a CCD bar code reader except that instead of having a single row of sensors, a video camera has hundreds of rows of sensors arranged in a two dimensional array so that they can generate an image.

   Large field-of-view readers use high resolution industrial cameras to capture multiple bar codes simultaneously. All the bar codes appearing in the photo are decoded instantly (ImageID patents and code creation tools) or by use of plugins (e.g. the Barcodepedia used a flash application and some web cam for querying a database), have been realized options for resolving the given tasks.

5. Omnidirectional Barcode Readers

   Omnidirectional scanning uses "series of straight or curved scanning lines of varying directions in the form of a starburst, a Lissajous pattern, or other multiangle arrangement are projected at the symbol and one or more of them will be able to cross all of the symbol's bars and spaces, no matter what the orientation Almost all of them use a laser. Unlike the simpler single-line laser scanners, they produce a pattern of beams in varying orientations allowing them to read barcodes presented to it at different angles. Most of them use a single rotating polygonal mirror and an arrangement of several fixed mirrors to generate their complex scan patterns.

   Omnidirectional scanners are most familiar through the horizontal scanners in supermarkets, where packages are slid over a glass or sapphire window. There are a range of different omnidirectional units available which can be used for differing scanning applications, ranging from retail type applications with the barcodes read only a few centimetres away from the scanner to industrial conveyor scanning where the unit can be a couple of metres away or more from the code. Omnidirectional scanners are also better at reading poorly printed, wrinkled, or even torn barcodes.

4.2.2 Features Of Barcode Scanner

1. Use of barcodes provides a fast, easy and accurate mechanism to enter data into a computer system for data collection or data lookup.

2. Accelerates work flow efficiency and speed ups throughput process

3. Eliminate data entry errors

4. Achieve data accuracy in back end host application

5. The barcode scanner interprets a unique identity of every product

6. The occurrence of errors is almost zero

7. The process is time and cost-effective

8. Access to total production costs is possible

9. There is a huge saving in the terms of labor effort

Barcode scanners have a positive impact on both the commercial and industrial sector. In the commercial segment, the usage of barcode scanners has reduced the time and effort at the process of billing. In the industrial segment, the barcode scanners have a positive impact in many areas increasing operating efficiency and the productivity.

4.2.3 Layout Of Barcode Scanner

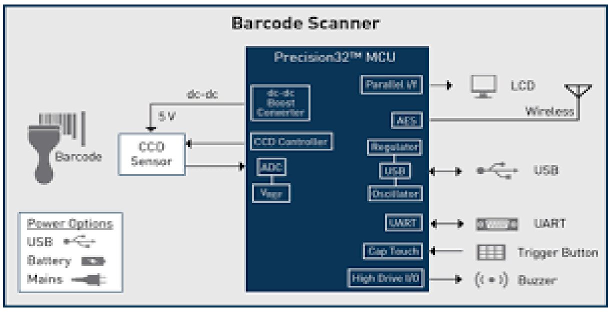


Figure 4.7: Layout Of Barcode Scanner

4.2.4 Resolution Of Barcode Scanner

The scanner resolution is measured by the size of the dot of light emitted by the reader. If this dot of light is wider than any bar or space in the bar code, then it will overlap two elements (two spaces or two bars) and it may produce wrong output. On the other hand, if a too small dot of light is used, then it can misinterpret any spot on the bar code making the final output wrong.

The most commonly used dimension is 13 thou (0.013 in or 0.33 mm), although some scanners can read codes with dimensions as small as 3 thou (0.003 in or 0.075 mm). Most manufacturers advertise bar code resolution in mil, which is interchangeable with thou. Smaller bar codes must be printed at high resolution to be read accurately.

4.3 Load cell

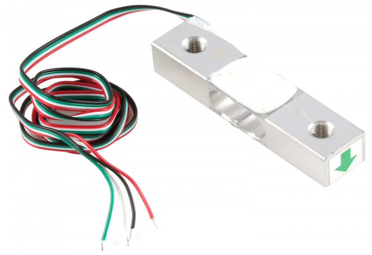


Figure 4.8: Load Cell

A load cell is a transducer that is used to create an electrical signal whose magnitude is directly proportional to the force being measured. The various types of load cells include hydraulic load cells, pneumatic load cells and strain gauge load cells.Strain gauge load cells convert the load acting on them into electrical signals. The gauges themselves are bonded onto a beam or structural member that deforms when weight is applied. In most cases, four strain gauges are used to obtain maximum sensitivity and temperature compensation. Two of the gauges are usually in tension can be represented as T1 and T2,and two in compression can be represented as C1 and C2, and are wired with compensation adjustments. The strain gauge load cell is fundamentally a spring optimized for strain measurement. When weight is applied to the load cell, gauges C1 and C2 compress decreasing their resistances. Simultaneously, gauges T1 and T2 are stretched increasing their resistances. The change in resistances causes more current to flow through C1 and C2 and less current to flow through T1 and T2. Thus a potential difference is felt between the output or signal leads of the load cell.When weight is applied, the strain changes the electrical resistance of the gauges in proportion to the load. Other load cells are fading into obscurity, as strain gauge load cells continue to increase their accuracy.

4.3.1 Characteristics Of Load Cell

1. Applied forces

   (a) The nominal applied force is that of the normal use of the transducer. A 10

   (b) The maximum tolerated force without deterioration is the force that can be applied on the transducer without permanently altering its capacity to measure forces. The conservation of calibration results is not guaranteed for this load. It usually amounts to 130

   (c) The breaking load is that causing the test specimen to break subject to a strain higher than the maximum strain tolerated by the material constituting the test specimen

2. Sensitivity

   (a) The sensitivity of the transducer is the existing ratio between the voltage released and received by the transducer, which is loaded at the nominal force. It is expressed in mV/V. This value represents the maximum strain applied to the test specimen.

   (b) The lower the sensibility, the weaker the level of strain applied to the transducer, and the better these metrological characteristics will be retained. Sensitivity values often range between 1.5 and 4 mV/V.

   (c) A linear transducer translates into a constant sensitivity. For this to happen, the test specimen must have certain specific characteristics not found in a simple cylindrical rod generating slightly non-linear strains.

3. Effect of temperature

   (a) Temperature affects the main elements constituting a force transducer. It affects :

   (b) The test specimen, modifying its elasticity. This variation has a relative value of approximately 0.1

   (c) The strain gauges, modifying their electric resistance

4.3.2 Wiring Of Load Cell

The full-bridge cells come typically in four-wire configuration. The wires to the top and bottom end of the bridge are the excitation (often labelled E+ and EâĹŠ, or Ex+ and ExâĹŠ), the wires to its sides are the signal (labelled S+ and SâĹŠ). Ideally, the voltage difference between S+ and SâĹŠ is zero under zero load, and grows proportionally to the load cell's mechanical load.

Sometimes a six-wire configuration is used. The two additional wires are "sense" (Sen+ and SenâĹŠ), and are connected to the bridge with the Ex+ and Ex- wires, in a fashion similar to four-terminal sensing. With these additional signals, the controller can compensate for the change in wire resistance due to e.g. temperature fluctuations.

The individual resistors on the bridge usually have resistance of 350 ÎŹ. Sometimes other values (typically 120 ÎŹ, 1,000 ÎŹ) can be encountered.

The bridge is typically electrically insulated from the substrate. The sensing elements are in close proximity and in good mutual thermal contact, to avoid differential signals caused by temperature differences.

4.3.3 Excitation and Rated Output Of A Load Cell

The bridge is excited with stabilized voltage (usually 10V, but can be 20V, 5V, or less for battery powered instrumentation). The difference voltage proportional to the load then appears on the signal outputs. The cell output is rated in millivolts per volt (mV/V) of the difference voltage at full rated mechanical load. So a 2.96 mV/V load cell will provide 29.6 millivolt signal at full load when excited with 10 volts.

Typical sensitivity values are 1 to 3 mV/V. Typical maximum excitation voltage is around 15 volts.

4.3.4 Load Cells weighing performances

Load cells are very commonly used to weight in industrial environment. They can be installed on hoppers, reactors...etc... and allow to control the weight in the capacity, which is often of critical importance for an industrial process. Some performance characteristics of the load cells must be defined and specified to make sure they will cope with the expected service. Among those design characteristics are :

- Combined error
- Minimum verification interval
- Resolution

4.4 Arduino UNO

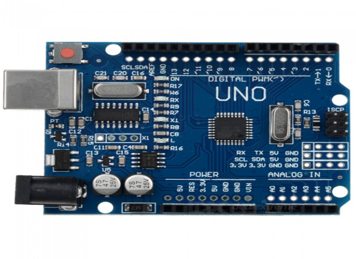


Figure 4.9: Arduino UNO

Arduino is an open source computer hardware and software company, project, and user community that designs and manufactures Single Board mic and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical and digital world.The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License (LGPL) or the GNU General Public License (GPL), permitting the manufacture of Arduino boards and software distribution by anyone.Arduino boards are available commercially in preassembled form, or as do-it-yourself (DIY) kits Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards or Breadboards (shields) and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment (IDE) based on the Processing language project. The Arduino Uno is a microcontroller board based on the ATmega328. Arduino is an open-source, prototyping platform and its simplicity makes it ideal for hobbyists to use as well as professionals. The Arduino Uno has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

4.4.1 Arduino Uno Pinout

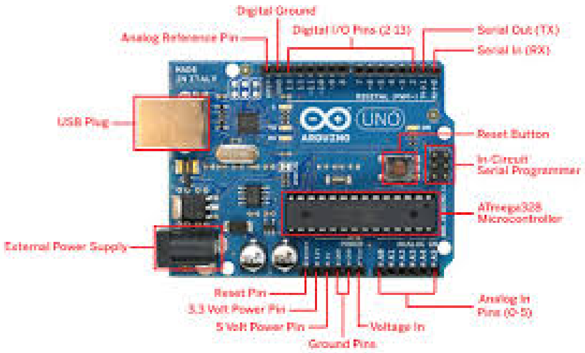


Figure 4.10: Arduino UNO Pinout

4.4.2 Interfacing Arduino UNO With USB Shield

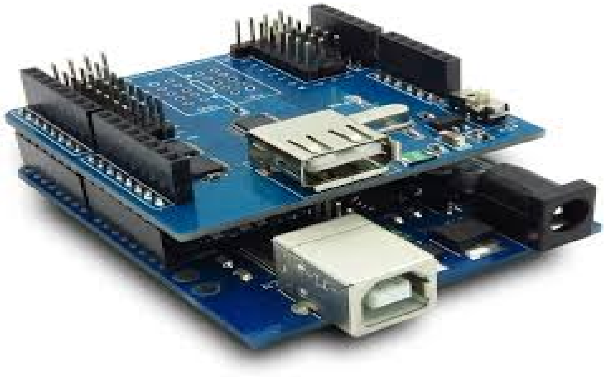


Figure 4.11: Arduino UNO with USB Shield

The Arduino USB Host Shield allows you to connect a USB device to your Arduino board. The Arduino USB Host Shield is based on the MAX3421E (datasheet), which is a USB peripheral/host controller containing the digital logic and analog circuitry necessary to implement a full-speed USB peripheral or a full-/low-speed host compliant to USB specification rev 2.0. The shield isTinkerKit compatible, which means you can quickly create projects by plugging TinkerKit modules onto the board.

4.4.3 Devices Supported By Shield

1. HID devices: keyboards, mice, joysticks, etc.

2. Game controllers: Sony PS3, Nintendo Wii, Xbox360.

3. USB to serial converters: FTDI, PL-2303, ACM, as well as certain cell phones and GPS receivers.

4. ADK-capable Android phones and tables.

5. Digital cameras: Canon EOS, Powershot, Nikon DSLRs and Leica, as well as generic PTP.

6. Mass storage devices: USB sticks, memory card readers, external hard drives, etc.

4.4.4 Official Boards

The original Arduino hardware was produced by the Italian company Smart Projects. Some Arduino-branded boards have been designed by the American companies SparkFun Electronics and Adafruit Industries. As of 2016, 17 versions of the Arduino hardware have been commercially produced.

Figure 4.12: Arduino Diecimila

4.4.5 Shields

Arduino and Arduino-compatible boards use printed circuit expansion boards called shields, which plug into the normally supplied Arduino pin headers. Shields can provide motor controls for 3D printing and other applications, Global Positioning System (GPS), Ethernet, liquid crystal display (LCD), or breadboarding (prototyping). Several shields can also be made do it yourself (DIY).

Figure 4.13: Adafruit Datalogging Shield with a SD card slot

Figure 4.14: Screw-terminal breakout shield in a wing-type format

4.4.6 Applications

- Arduboy, a handheld game console based on Arduino
- Arduino Motion Control Rig
- Arduinome, a MIDI controller device that mimics the Monome
- ArduinoPhone, a do-it-yourself cellphone
- Ardupilot, drone software and hardware

- ArduSat, a cubesat based on Arduino.
- Automatic titration system based on Arduino and stepper motor C-STEM Studio, a platform for hands-on integrated learning of computing, science, technology, engineering, and mathematics (C-STEM) with robotics.
- DC motor control using Arduino and H-Bridge
- Data loggers for scientific research

4.5 HX711 Load Cell Amplifier

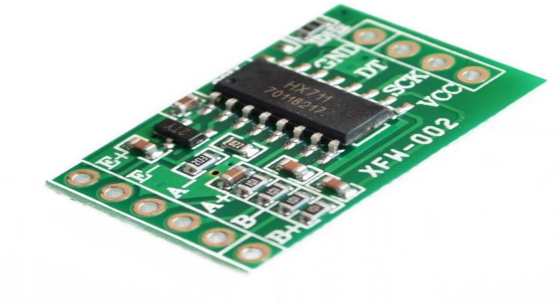


Figure 4.15: HX711

This module uses 24 high precision A/D converter chip HX711. It is a specially designed for the high precision electronic scale design, with two analog input channel, the internal integration of 128 times the programmable gain amplifier. The input circuit can be configured to provide a bridge type pressure bridge (such as pressure, weighing sensor mode), is of high precision, low cost is an ideal sampling front-end module.
Specifications are as follows

- Differential input voltage: Âś40mV (Full-scale differential input voltage is Âś 40mV)
- Data accuracy: 24 bit (24 bit A / D converter chip.)
- Refresh frequency: 10/80 Hz
- Operating Voltage: 2.7V to 5VDC
- Operating current: <10 mA
- Size: 24x16mm

4.6 GSM Module

A GSM modem is a device which can be either a mobile phone or a modem device which can be used to make a computer or any other processor communicate over a network. A GSM modem requires a SIM card to be operated and operates over a network range subscribed by the network operator. It can be connected to a computer through serial, USB or Bluetooth connection.

A GSM modem can also be a standard GSM mobile phone with the appropriate cable and software driver to connect to a serial port or USB port on your computer. GSM modem is usually preferable to a GSM mobile phone. The GSM modem has wide range of applications in transaction terminals, supply chain management, security applications, weather stations and GPRS mode remote data logging.

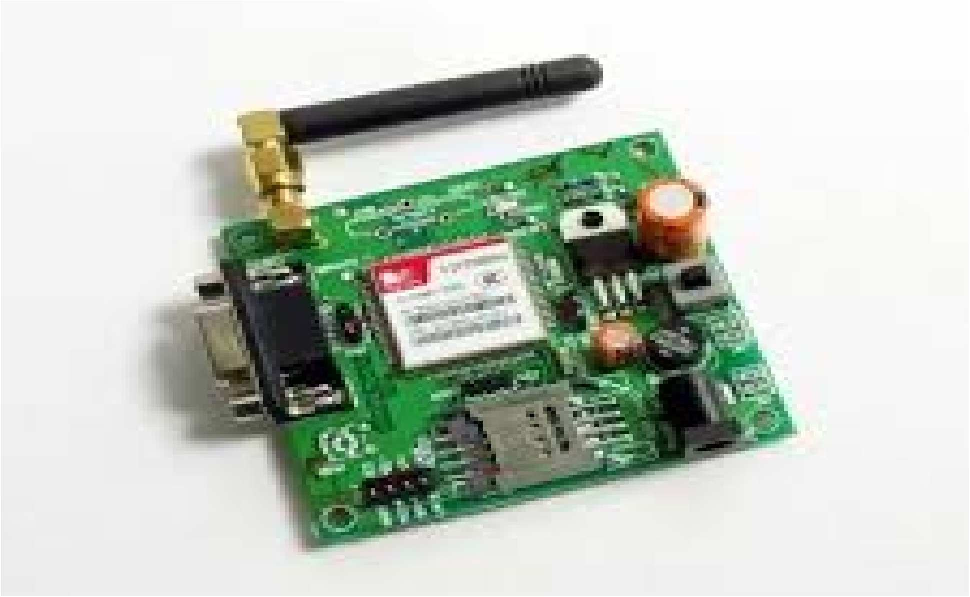


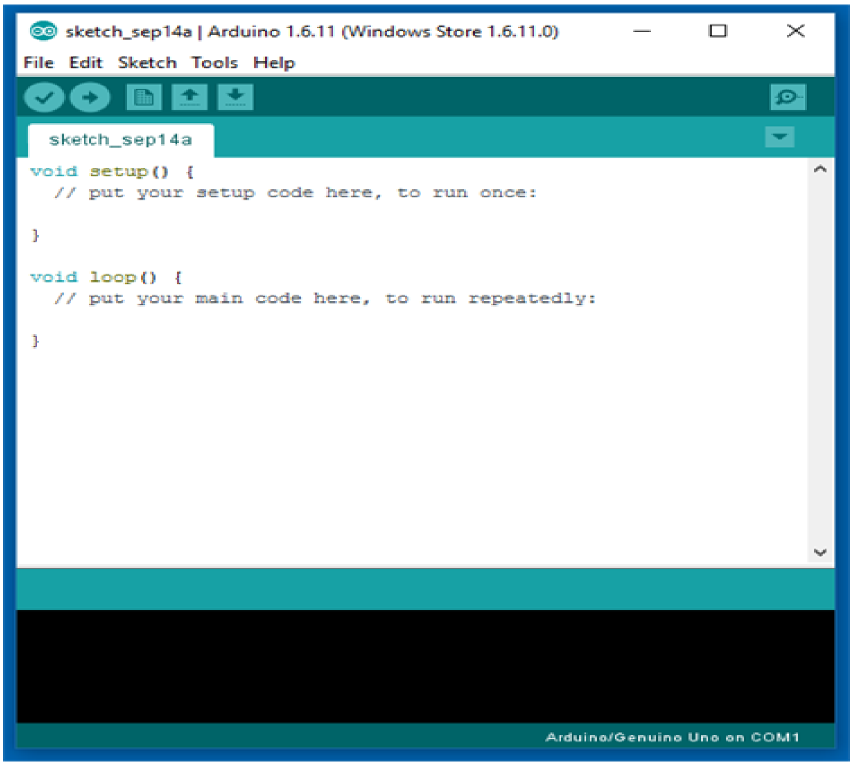
Figure 4.16: GSM Module

A GSM/GPRS module assembles a GSM/GPRS modem with standard communication interfaces like RS-232 (Serial Port), USB etc., so that it can be easily interfaced with a computer or a microprocessor / microcontroller based system. The power supply circuit is also built in the module that can be activated by using a suitable adaptor.

Chapter 5

Software Implementation

5.1 Arduino Ide


sketch_sep14a | Arduino 1.6.11 (Windows Store 1.6.11.0)
File Edit Sketch Tools Help
sketch_sep14a

```
void setup() {
  // put your setup code here, to run once:

}

void loop() {
  // put your main code here, to run repeatedly:

}
```

Arduino/Genuino Uno on COM1

Figure 5.1: Arduino Ide

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them. Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension .ino. The editor has features for cutting/-

pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom right-hand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

A program for Arduino may be written in any programming language with compilers that produce binary machine code for the target processor. Atmel provides a development environment for their microcontrollers, AVR and the newer Atmel Studio.

The Arduino project provides the Arduino integrated development environment (IDE), which is a cross-platform application written in the programming language Java. It originated from the IDE for the languages Processing and Wiring. It includes a code editor with features such as text cutting and pasting, searching and replacing text, automatic indenting, brace matching, and syntax highlighting, and provides simple one-click mechanisms to compile and upload programs to an Arduino board. It also contains a message area, a text console, a toolbar with buttons for common functions and a hierarchy of operation menus.

[8]

5.1.1 Program Structure

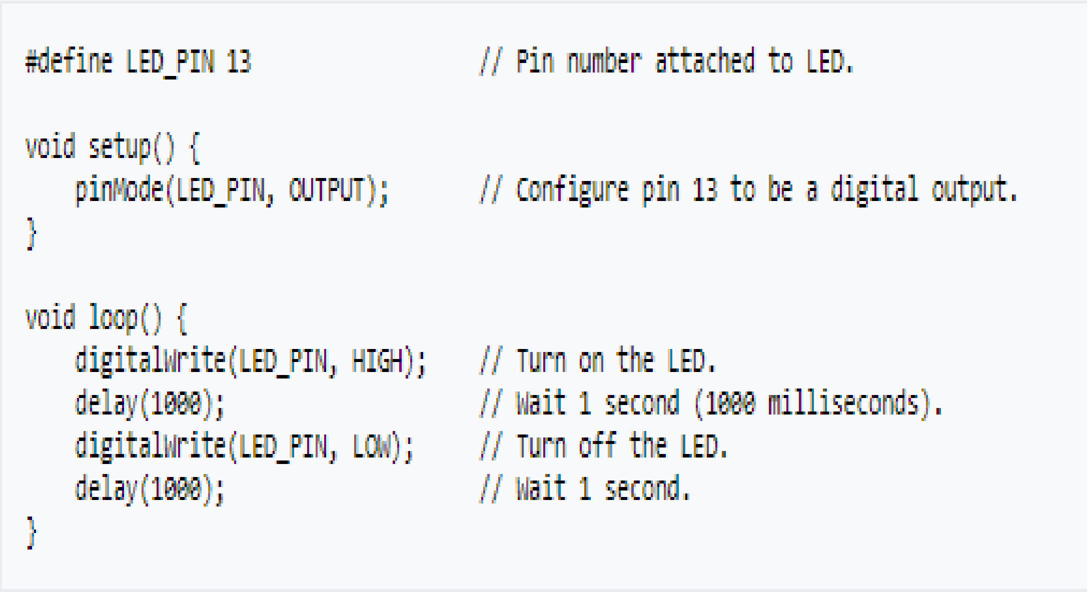
A minimal Arduino C/C++ program consist of only two functions:

1. setup(): This function is called once when a sketch starts after power-up or reset. It is used to initialize variables, input and output pin modes, and other libraries needed in the sketch

2. loop(): After setup() has been called, function loop() is executed repeatedly in the main program. It controls the board until the board is powered off or is reset

Most Arduino boards contain a light-emitting diode (LED) and a load resistor connected between pin 13 and ground, which is a convenient feature for many tests and program functions.

An Example of a typical program for a beginning Arduino programmer blinks a LED repeatedly.



```
#define LED_PIN 13                  // Pin number attached to LED.

void setup() {
    pinMode(LED_PIN, OUTPUT);       // Configure pin 13 to be a digital output.
}

void loop() {
    digitalWrite(LED_PIN, HIGH);    // Turn on the LED.
    delay(1000);                    // Wait 1 second (1000 milliseconds).
    digitalWrite(LED_PIN, LOW);     // Turn off the LED.
    delay(1000);                    // Wait 1 second.
}
```

Figure 5.2: LED Blinking Program

This program uses the functions pinMode(), digitalWrite(), and delay(), which are provided by the internal libraries included in the IDE environment.The program is usually loaded in the Arduino by the manufacturer.

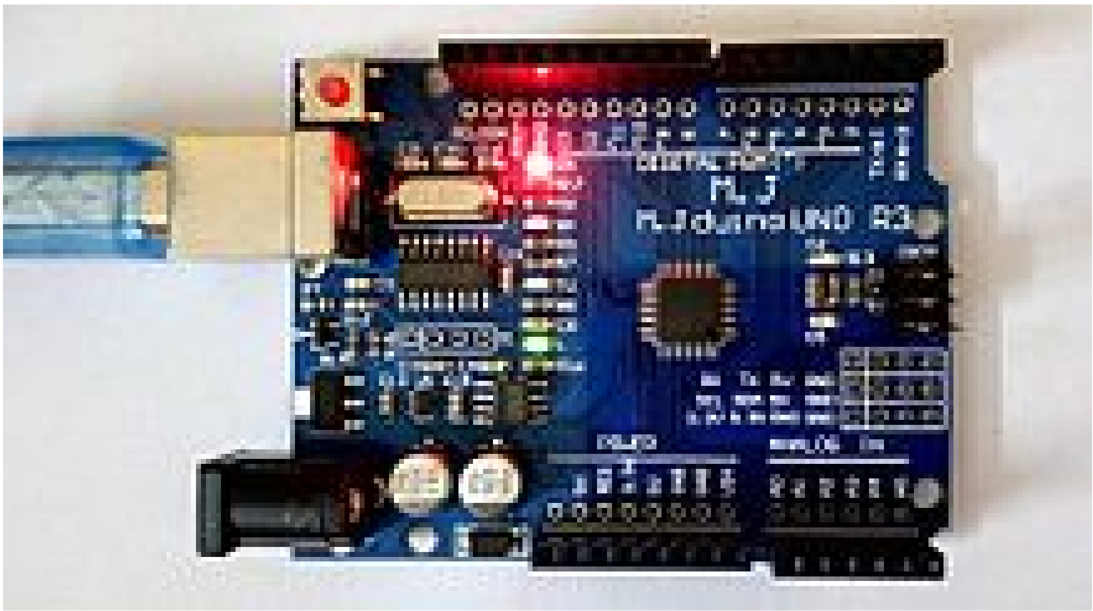
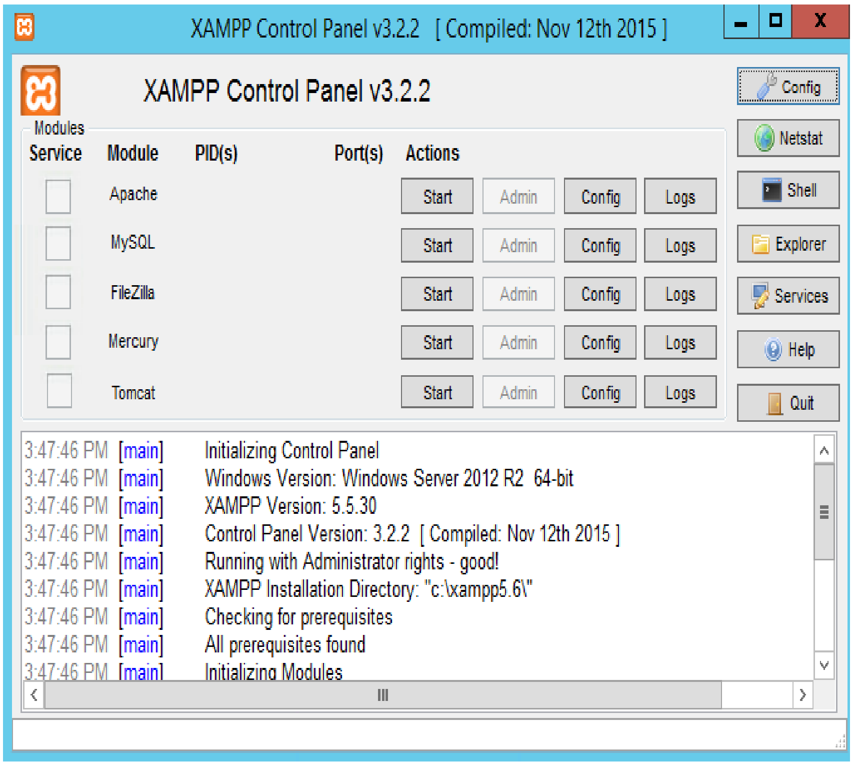


Figure 5.3: Power LED (red) and User LED (green) attached to Pin 13 on an Arduino compatible board

5.2 XAMPP Server



```
3:47:46 PM  [main]   Initializing Control Panel
3:47:46 PM  [main]   Windows Version: Windows Server 2012 R2  64-bit
3:47:46 PM  [main]   XAMPP Version: 5.5.30
3:47:46 PM  [main]   Control Panel Version: 3.2.2  [ Compiled: Nov 12th 2015 ]
3:47:46 PM  [main]   Running with Administrator rights - good!
3:47:46 PM  [main]   XAMPP Installation Directory: "c:\xampp5.6\"
3:47:46 PM  [main]   Checking for prerequisites
3:47:46 PM  [main]   All prerequisites found
3:47:46 PM  [main]   Initializing Modules
```

Figure 5.4: Xamp

XAMPP is an open-source web server package that works on various platforms. It is actually an acronym with X meaning cross platform, A for Apache HTTP server, M for MySQL, P for PHP, and P for Perl. XAMPP was designed to help webpage developers, programmers, and designers check and review their work using their computers even without connection to the web or internet. So, basically XAMPP may be used to stand as pages for the internet even without connection to it. It can also be used to create and configure with databases written in MySQL and/or SQLite. And since XAMPP is designed as a cross-platform server package, it is available for a variety of operating systems and platforms like Microsoft Windows, Mac OS X, Linux, and Solaris. To use XAMPP, only one zip, exe or tar file is needed. Users just need to download this file and run the application. There is also not much configuration and tinkering to be done in terms of settings and its components. The XAMPP package is also updated on a regular basis to synchronize with the updates made on the different platforms involved in the package like Apache, PHP, Perl, and MySQL.

XAMPP requires only one zip, tar, 7z, or exe file to be downloaded and run, and little or no configuration of the various components that make up the web server is required. The Windows' version of XAMPP requires Microsoft Visual C++ 2017 Redistributable. XAMPP is regularly updated to the latest releases of Apache, MariaDB, PHP and Perl. It also comes with a number of other modules including OpenSSL, phpMyAdmin, MediaWiki, Joomla, WordPress and more. Self-contained, multiple instances of XAMPP can exist on a single computer, and any given instance can be copied from one computer to another. XAMPP is offered in both a full and a standard version (Smaller version).

5.2.1 Components In XAMPP

XAMPP has four primary components

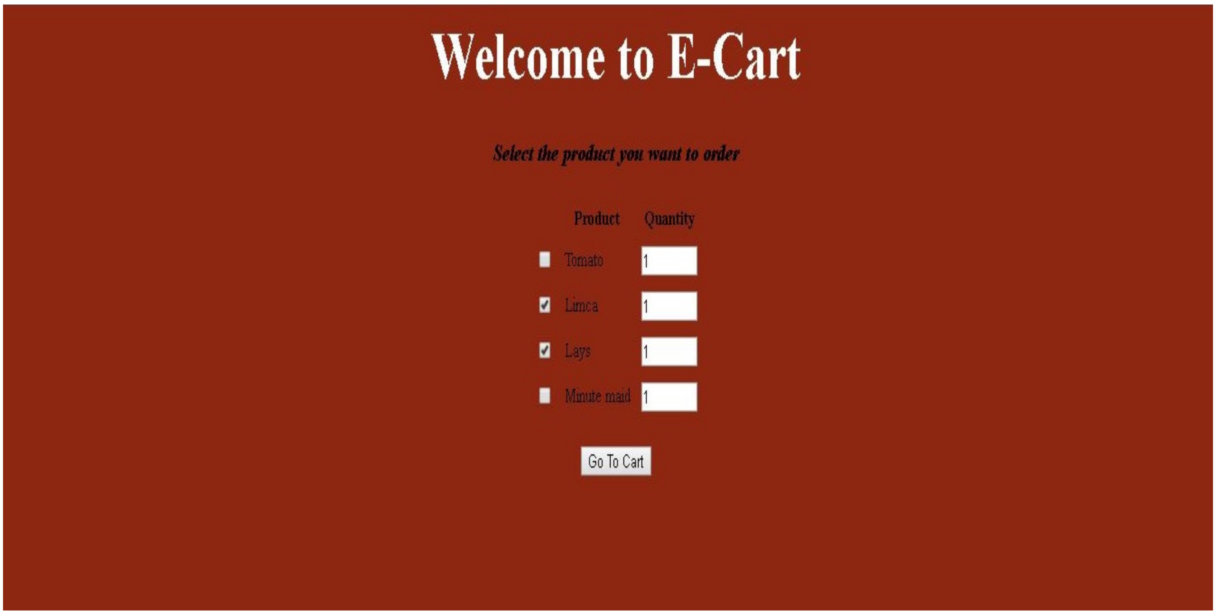
1. Apache: Apache is the actual web server application that processes and delivers web content to a computer. Apache is the most popular web server online, powering nearly 54

2. MySQL: Every web application, howsoever simple or complicated, requires a database for storing collected data. MySQL, which is open source, is the worldâĂŹs most popular database management system. It powers everything from hobbyist websites to professional platforms like WordPress. You can learn how to master PHP with this free MySQL database for beginners course.

3. PHP: PHP stands for Hypertext Preprocessor. It is a server-side scripting language that powers some of the most popular websites in the world, including WordPress and Facebook. It is open source, relatively easy to learn, and works perfectly with MySQL, making it a popular choice for web developers.

4. Perl: Perl is a high-level, dynamic programming language used extensively in network programming, system admin, etc. Although less popular for web development purposes, Perl has a lot of niche applications.

5.3 Webpage

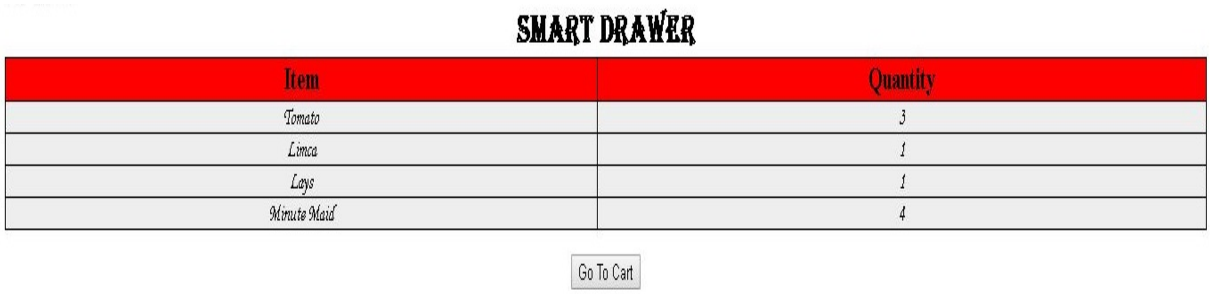


Welcome to E-Cart

Select the product you want to order

	Product	Quantity
☐	Tomato	1
☑	Limca	1
☑	Lays	1
☐	Minute maid	1

Figure 5.5: E-Cart Webpage



SMART DRAWER

Item	Quantity
Tomato	*3*
Limca	*1*
Lays	*1*
Minute Maid	*4*

Figure 5.6: Drawer Webpage

The Webpage is an interface between the user and the database, the user can view the items along with their quantity that are present in the drawer. The webpage generates a notification once the quantity for a particular item goes below the specified threshold. The user can select the desired product by checking the check box. The user can also enter the quantity of the product needed to be delivered. After the quantity and the products are selected the user need to click the submit button in order to place the order. If in case the user make some mistake while ordering then the user click the reset button to put the value in default.

5.3.1 Elements Of Webpage

1. Perceived (rendered) information:

2. Textual information: with diverse render variations.

3. Non-textual information:

   (a) Static images may be raster graphics, typically GIF, JPEG or PNG; or vector formats such as SVG or Flash.

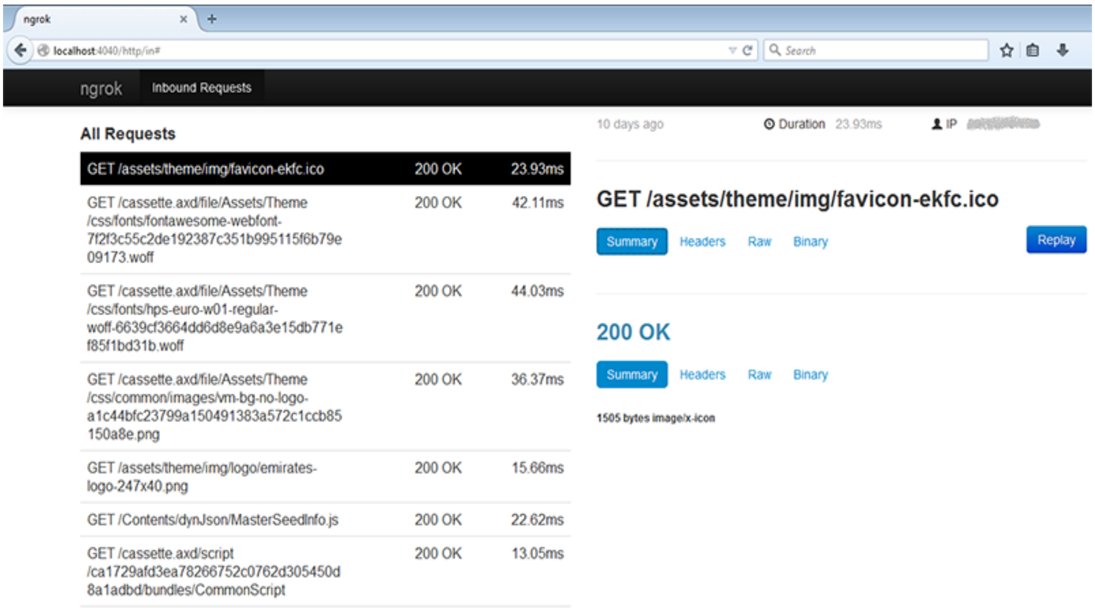
   (b) Animated images typically Animated GIF and SVG, but also Flash, Shockwave, or Java applet.

   (c) Audio, typically MP3, Ogg or various proprietary formats Video, WMV (Windows), RM (RealMedia), FLV (Flash Video), MPG, MOV (QuickTime)

5.4 Ngrok

Ngrok is a multiplatform tunnelling, reverse proxy software that establishes secure tunnels from a public endpoint such as internet to a locally running Network service while capturing all traffic for detailed inspection and replay. ngrok creates a tunnel from the public internet to a port on your local machine. You can give this URL to anyone to allow them to try out a web site you're developing without doing any deployment.

It captures all traffic through the tunnel. It displays information about the HTTP traffic for your inspection. Raw request/response bytes, parsed headers and form data, JSON/XML syntax checking and more are included. It can also replay requests.



All Requests

GET /assets/theme/img/favicon-ekfc.ico	200 OK	23.93ms
GET /cassette.axd/file/Assets/Theme /css/fonts/fontawesome-webfont-7f2f3c55c2de192387c351b995115f6b79e09173.woff	200 OK	42.11ms
GET /cassette.axd/file/Assets/Theme /css/fonts/hps-euro-w01-regular-woff-6639cf3664dd6d8e9a6a3e15db771ef85f1bd31b.woff	200 OK	44.03ms
GET /cassette.axd/file/Assets/Theme /css/common/images/vm-bg-no-logo-a1c44bfc23799a150491383a572c1ccb85150a8e.png	200 OK	36.37ms
GET /assets/theme/img/logo/emirates-logo-247x40.png	200 OK	15.66ms
GET /Contents/dynJson/MasterSeedInfo.js	200 OK	22.62ms
GET /cassette.axd/script /ca1729afd3ea78266752c0762d305450d8a1adbd/bundles/CommonScript	200 OK	13.05ms

10 days ago Duration 23.93ms IP [redacted]

GET /assets/theme/img/favicon-ekfc.ico

200 OK

1505 bytes image/x-icon

Figure 5.7: Ngrok Web Interface

By default, ngrok will use ngrok.com as a third-party relay. This service is provided at no-cost and without registration but it is possible to get additional features by signing up in the service (which is pay-as-you-want kind). However, it is possible to setup and use its own server.This package installs the client part of ngrok. It can be used directly with ngrok.com service or with your own server if you install the ngrok-server package.

Chapter 6

Results

6.1 Observations

The amount and the name of items present in the smart drawer was successfully updated on the database. The barcode scanner was used to scan the barcode on each item as it was kept into the drawer. The load cell was used to detect the change in the weight in the drawer the moment an item was placed into or out of the drawer. The barcode scanner scanned the id of an item and the weight of the drawer decreased, then it was concluded that the item with the scanned id has reduced by one quantity in the drawer.Similarly if item id is scanned and the weight increases, then it was concluded that the item with the corresponding scanned id has increased by one quantity in the drawer.This data of decrease /increase and the corresponding id of the item is sent serially to the Wi-Fi module, which in turn transmits this data to the database over the Internet and hence, the database is updated.The data in the database can be used to prepare a shopping list for the customer and also for generating alarms in case of decrease in quantity of an item below a certain level.In case of the alarm generated the user can then know about the decrease in the quantity of the specific item and place an order from the same. The webpage was coded in HTML and the database was coded in MySQL.The server used was a local XAMPP server for this purpose. The drawback of this system is the low sensitivity of the load cell i.e 0.02 kg.An item less than 20gm would not be detected by this system. A smart line following bot was created on which the trolley is to be mounted. The trolley with the smart line following bot underneath successfully follows the track and makes a stop at the specific location for the picking up of the required item and waits until the required amount of the items required are grabbed.

6.2 Future Scope

- This smart drawer can be used in the households to keep a track of grocery items and other items that are regularly used.
- This system can employed in large shopping marts like D-Marts.
- This system can also be employed in huge warehouses.
- This system can be improvised further by designing an automated packaging system for packing the items collected for a customer. Hence the entire shopping activity would become automated without human intervention.
- This system can be improvised by developing a robotic arm and mounting it on the trolley so that the required items can be automatically picked up and placed in the trolley from the stops where it halts.

Chapter 7

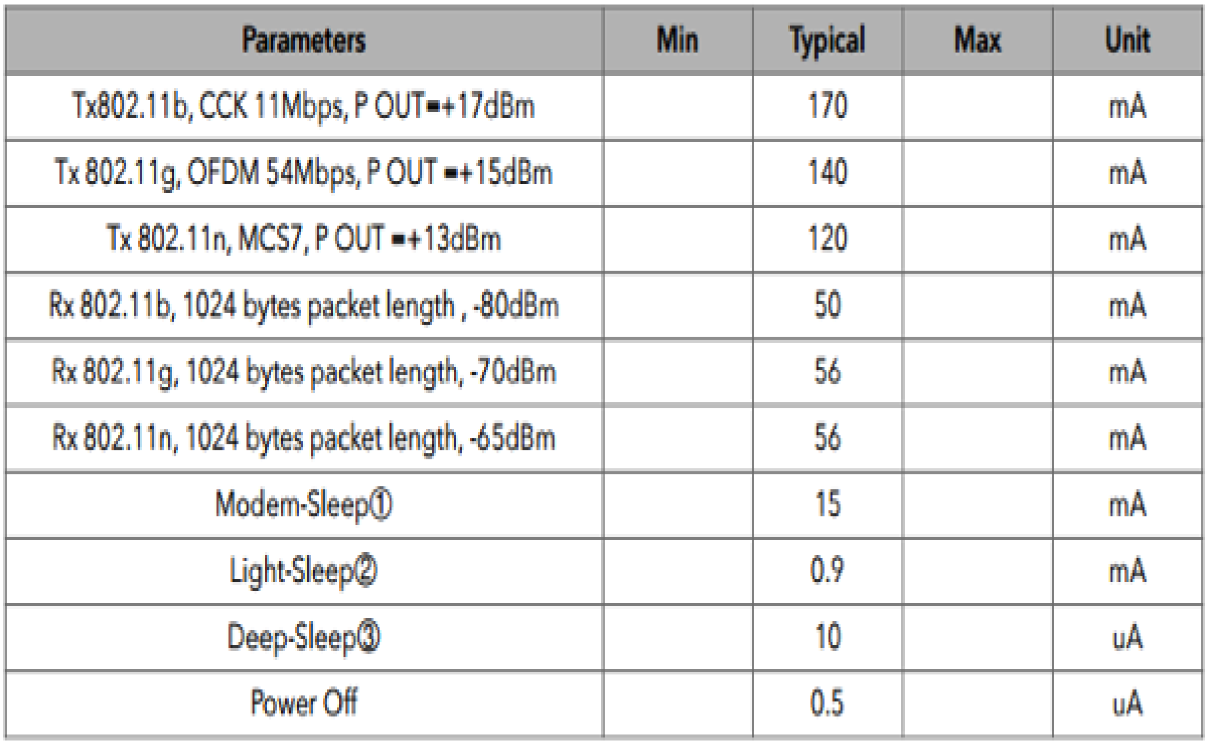
Conclusion

The amount and the name of items present in the smart drawer was successfully updated in the database. The barcode scanner was used to scan the barcode on each item as it was kept into the drawer. The load cell was used to detect the change in the weight in the drawer the moment an item was placed into or out of the drawer. The database can be used to store the shopping list by the customer and also for generating notification in case of decrease in quantity of an item below a certain level. A webpage was designed to view the amount and quantity of each item present in the drawer. Also orders for items can be placed on this webpage which in turn sends this list of items to the automated trolley.The automated trolley is a line following bot which moved from one stop to another depending on the list of items send to it.Two IR sensors were used to make the line following bot. Wifi module was used to receive data from the server and to transmit it to the trolley.
This system enables the user to keep a track of items present in the drawer and also alerts the user to shop when the quantity of each item in the drawer goes low.The user is able to place order for the items required online and the items can be collected using the automated trolley without having to keep a track of the list of items that one is supposed to buy.This relieves the customers from the burden of keeping track of items present in the house and also the burden of making a shopping list and to keep track of it while shopping.

Appendix A

Appendix

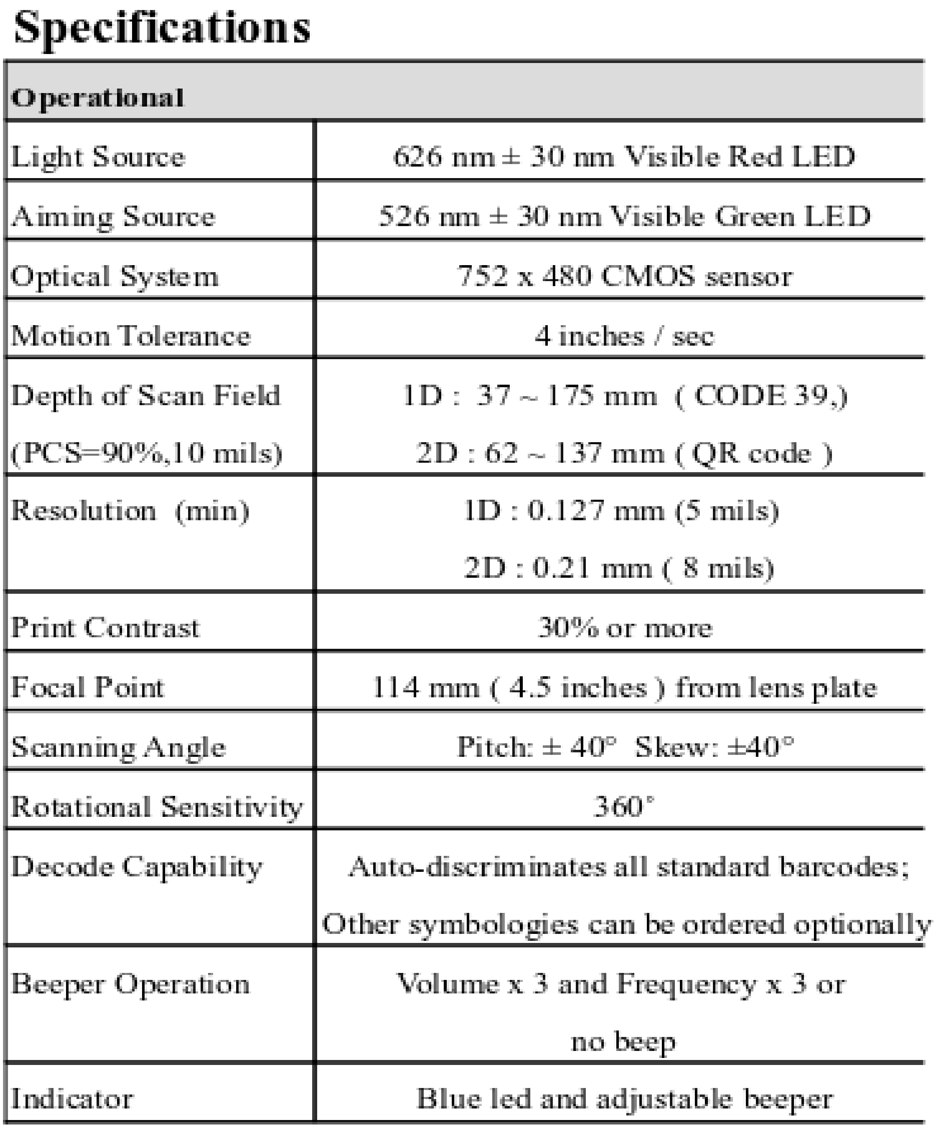
A.1 ESP8266 Data Sheet



Parameters	Min	Typical	Max	Unit
Tx802.11b, CCK 11Mbps, P OUT=+17dBm		170		mA
Tx 802.11g, OFDM 54Mbps, P OUT =+15dBm		140		mA
Tx 802.11n, MCS7, P OUT =+13dBm		120		mA
Rx 802.11b, 1024 bytes packet length , -80dBm		50		mA
Rx 802.11g, 1024 bytes packet length, -70dBm		56		mA
Rx 802.11n, 1024 bytes packet length, -65dBm		56		mA
Modem-Sleep①		15		mA
Light-Sleep②		0.9		mA
Deep-Sleep③		10		uA
Power Off		0.5		uA

Figure A.1: ESP Datasheet

A.2 Barcode Scanner Data Sheet

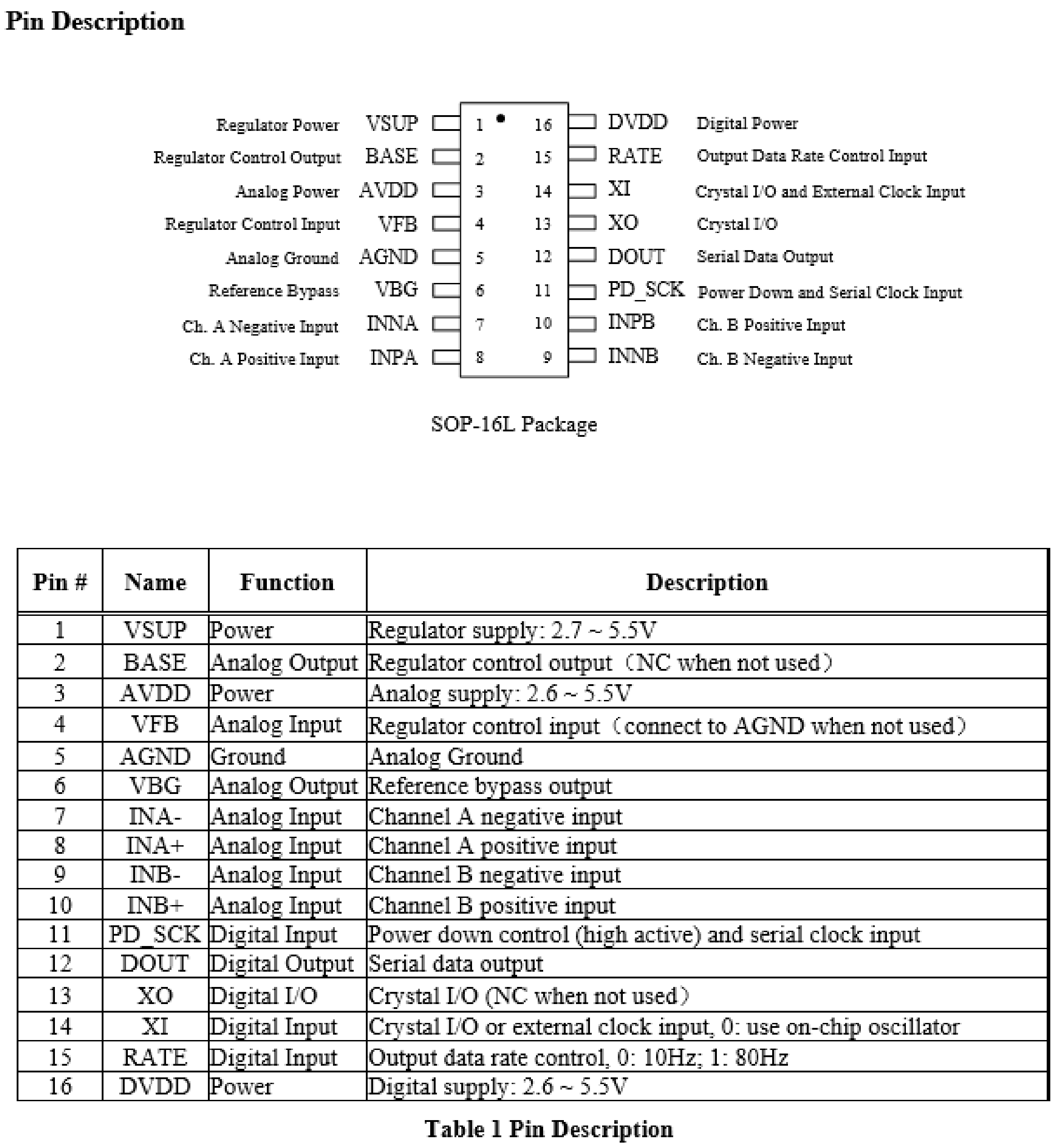


Specifications

Operational	
Light Source	626 nm ± 30 nm Visible Red LED
Aiming Source	526 nm ± 30 nm Visible Green LED
Optical System	752 x 480 CMOS sensor
Motion Tolerance	4 inches / sec
Depth of Scan Field (PCS=90%,10 mils)	1D : 37 ~ 175 mm (CODE 39,) 2D : 62 ~ 137 mm (QR code)
Resolution (min)	1D : 0.127 mm (5 mils) 2D : 0.21 mm (8 mils)
Print Contrast	30% or more
Focal Point	114 mm (4.5 inches) from lens plate
Scanning Angle	Pitch: ± 40° Skew: ±40°
Rotational Sensitivity	360°
Decode Capability	Auto-discriminates all standard barcodes; Other symbologies can be ordered optionally
Beeper Operation	Volume x 3 and Frequency x 3 or no beep
Indicator	Blue led and adjustable beeper

Figure A.2: Barcode Scanner Datasheet

A.3 HX711 Data Sheet



Pin Description

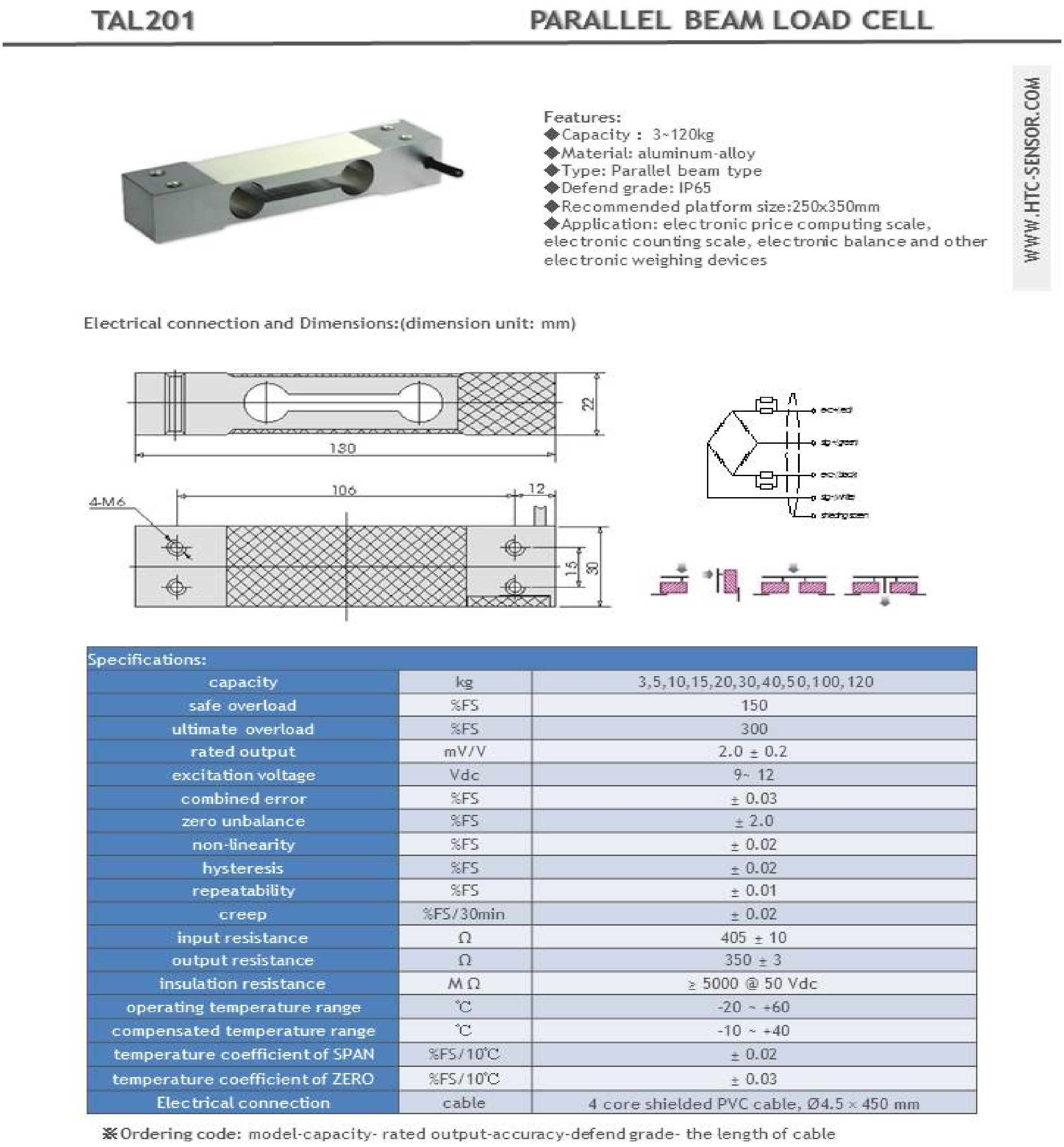
Regulator Power VSUP 1 16 DVDD Digital Power
Regulator Control Output BASE 2 15 RATE Output Data Rate Control Input
Analog Power AVDD 3 14 XI Crystal I/O and External Clock Input
Regulator Control Input VFB 4 13 XO Crystal I/O
Analog Ground AGND 5 12 DOUT Serial Data Output
Reference Bypass VBG 6 11 PD_SCK Power Down and Serial Clock Input
Ch. A Negative Input INNA 7 10 INPB Ch. B Positive Input
Ch. A Positive Input INPA 8 9 INNB Ch. B Negative Input
SOP-16L Package

Pin #	Name	Function	Description
1	VSUP	Power	Regulator supply: 2.7 ~ 5.5V
2	BASE	Analog Output	Regulator control output（NC when not used）
3	AVDD	Power	Analog supply: 2.6 ~ 5.5V
4	VFB	Analog Input	Regulator control input（connect to AGND when not used）
5	AGND	Ground	Analog Ground
6	VBG	Analog Output	Reference bypass output
7	INA-	Analog Input	Channel A negative input
8	INA+	Analog Input	Channel A positive input
9	INB-	Analog Input	Channel B negative input
10	INB+	Analog Input	Channel B positive input
11	PD_SCK	Digital Input	Power down control (high active) and serial clock input
12	DOUT	Digital Output	Serial data output
13	XO	Digital I/O	Crystal I/O (NC when not used）
14	XI	Digital Input	Crystal I/O or external clock input, 0: use on-chip oscillator
15	RATE	Digital Input	Output data rate control, 0: 10Hz; 1: 80Hz
16	DVDD	Power	Digital supply: 2.6 ~ 5.5V

Table 1 Pin Description

Figure A.3: HX711 Datasheet

A.4 Load Cell Data Sheet



TAL201

PARALLEL BEAM LOAD CELL

Features:

◆Capacity : 3~120kg

◆Material: aluminum-alloy

◆Type: Parallel beam type

◆Defend grade: IP65

◆Recommended platform size:250x350mm

◆Application: electronic price computing scale, electronic counting scale, electronic balance and other electronic weighing devices

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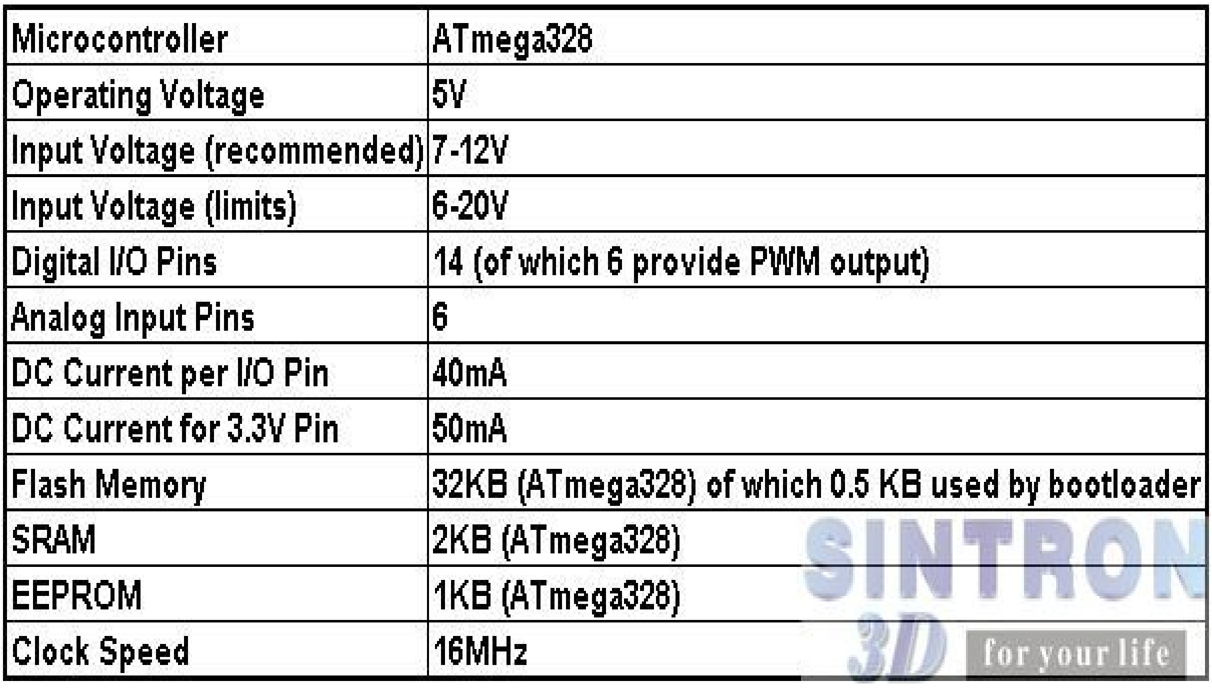
Electrical connection and Dimensions:(dimension unit: mm)

Specifications:		
capacity	kg	3,5,10,15,20,30,40,50,100,120
safe overload	%FS	150
ultimate overload	%FS	300
rated output	mV/V	2.0 ± 0.2
excitation voltage	Vdc	9~ 12
combined error	%FS	± 0.03
zero unbalance	%FS	± 2.0
non-linearity	%FS	± 0.02
hysteresis	%FS	± 0.02
repeatability	%FS	± 0.01
creep	%FS/30min	± 0.02
input resistance	Ω	405 ± 10
output resistance	Ω	350 ± 3
insulation resistance	MΩ	≥ 5000 @ 50 Vdc
operating temperature range	℃	-20 ~ +60
compensated temperature range	℃	-10 ~ +40
temperature coefficient of SPAN	%FS/10℃	± 0.02
temperature coefficient of ZERO	%FS/10℃	± 0.03
Electrical connection	cable	4 core shielded PVC cable, Ø4.5 × 450 mm

※Ordering code: model-capacity- rated output-accuracy-defend grade- the length of cable

Figure A.4: Load Cell Datasheet

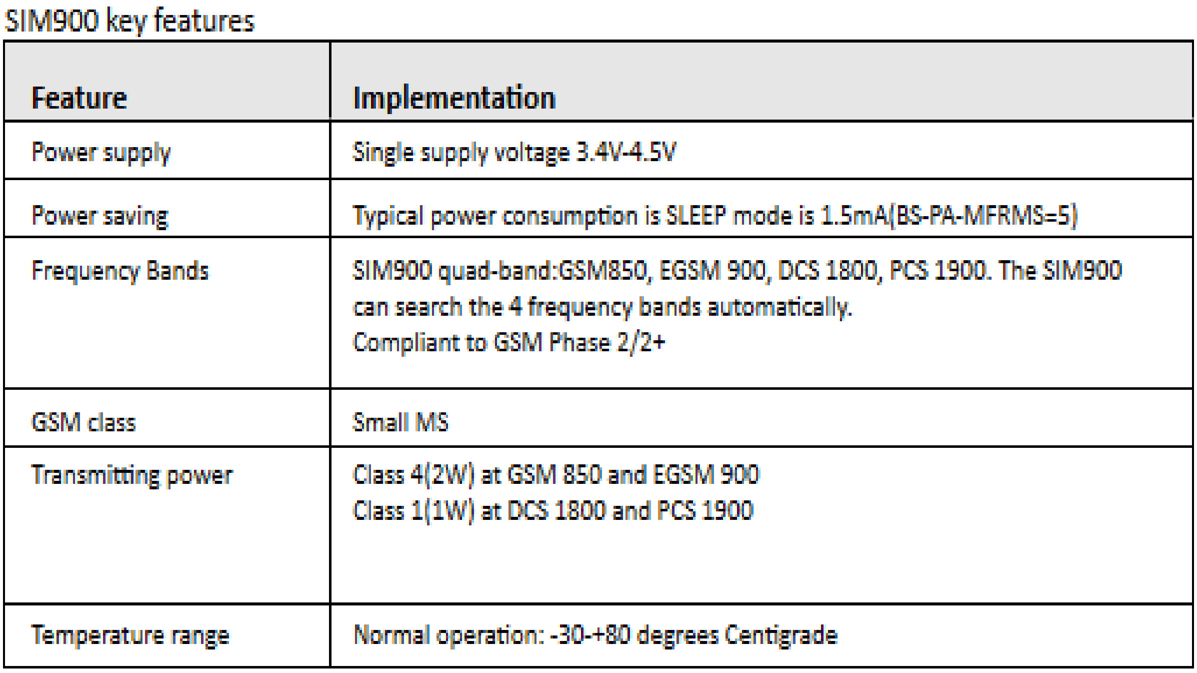
A.5 Arduino Data Sheet



Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40mA
DC Current for 3.3V Pin	50mA
Flash Memory	32KB (ATmega328) of which 0.5 KB used by bootloader
SRAM	2KB (ATmega328)
EEPROM	1KB (ATmega328)
Clock Speed	16MHz

Figure A.5: Arduino Datasheet

A.6 GSM Module Data Sheet

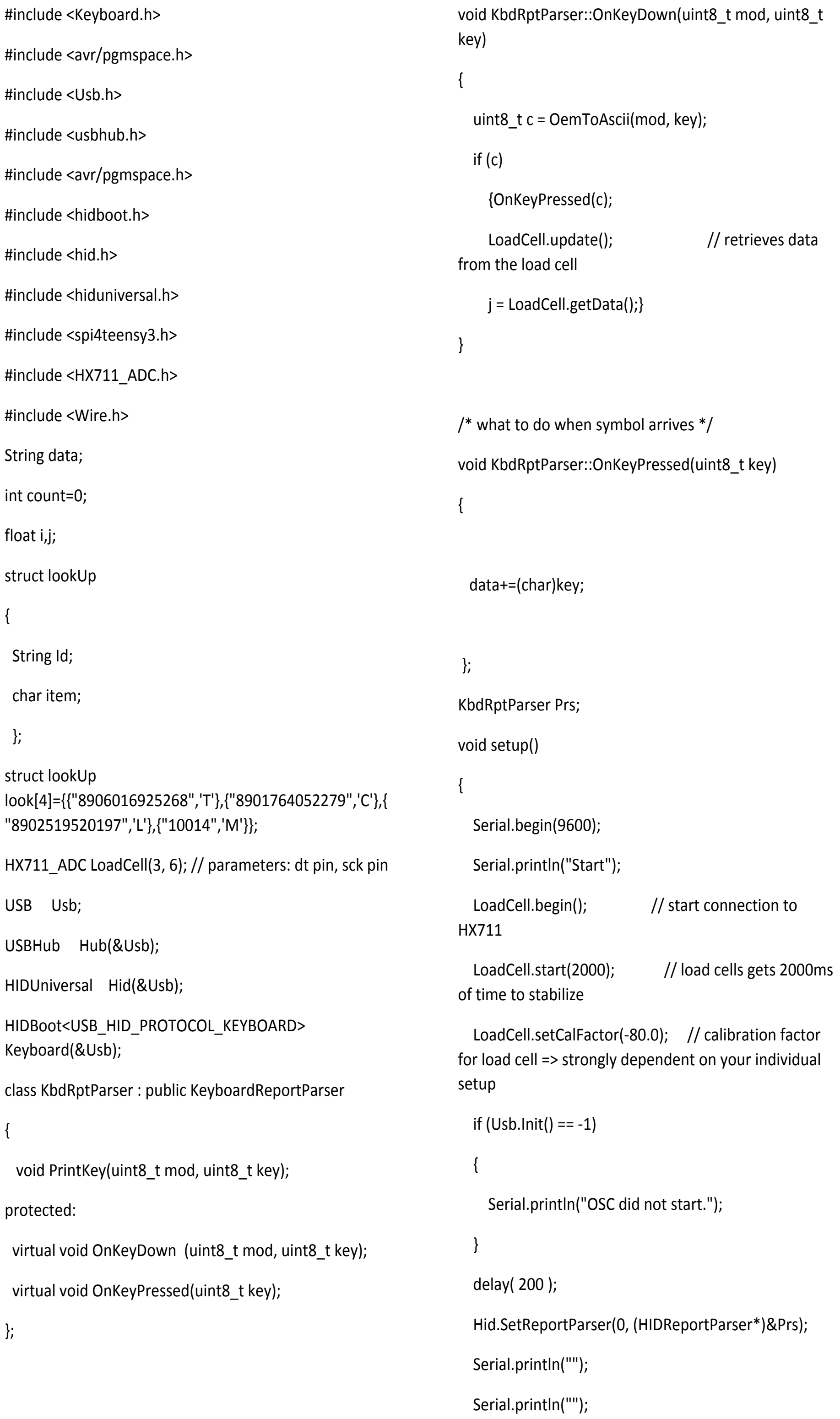


SIM900 key features

Feature	Implementation
Power supply	Single supply voltage 3.4V-4.5V
Power saving	Typical power consumption is SLEEP mode is 1.5mA(BS-PA-MFRMS=5)
Frequency Bands	SIM900 quad-band:GSM850, EGSM 900, DCS 1800, PCS 1900. The SIM900 can search the 4 frequency bands automatically. Compliant to GSM Phase 2/2+
GSM class	Small MS
Transmitting power	Class 4(2W) at GSM 850 and EGSM 900 Class 1(1W) at DCS 1800 and PCS 1900
Temperature range	Normal operation: -30-+80 degrees Centigrade

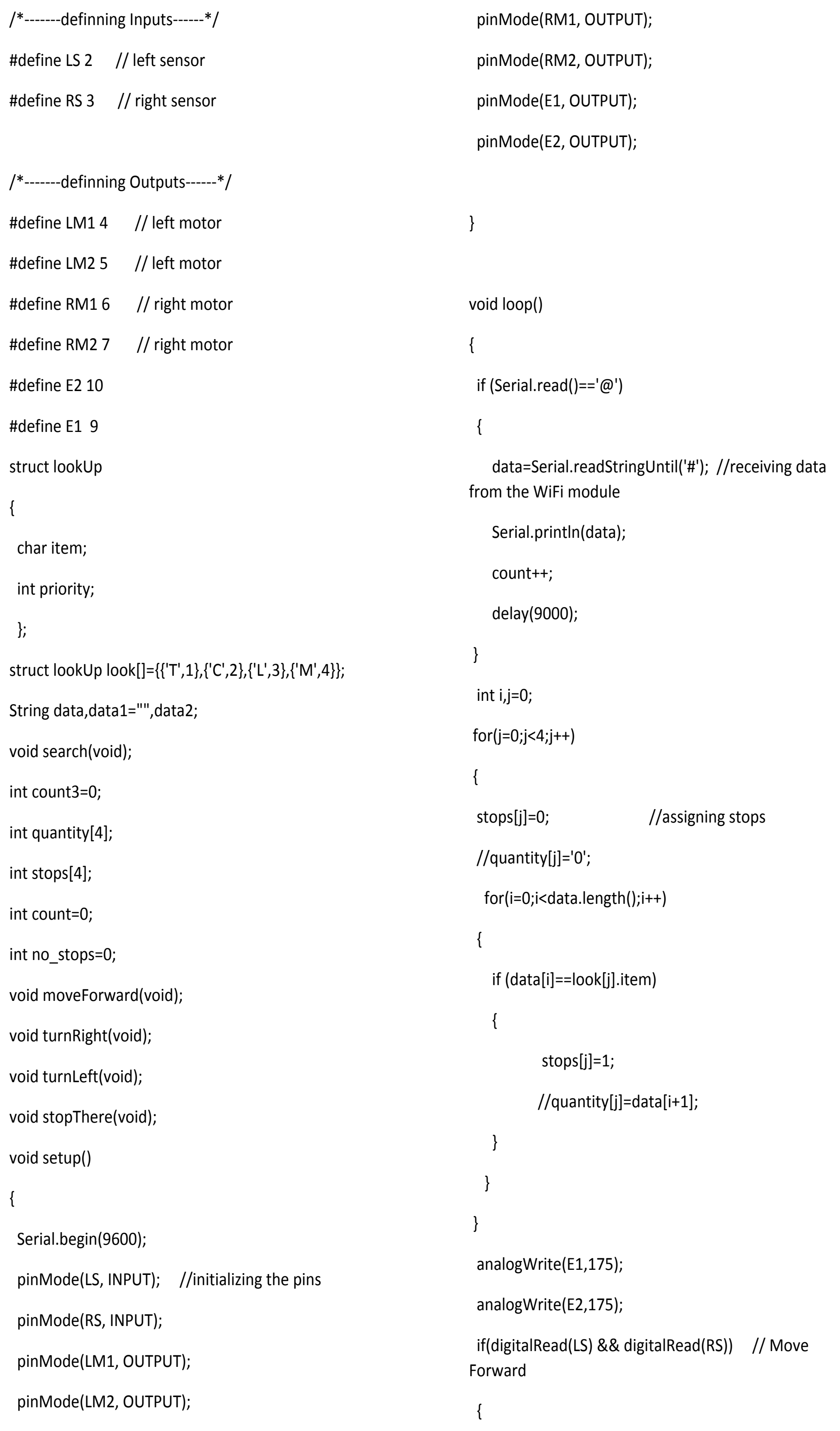
Figure A.6: GSM Module Datasheet

A.7 Smart Drawer Code



```
#include <Keyboard.h>

#include <avr/pgmspace.h>

#include <Usb.h>

#include <usbhub.h>

#include <avr/pgmspace.h>

#include <hidboot.h>

#include <hid.h>

#include <hiduniversal.h>

#include <spi4teensy3.h>

#include <HX711_ADC.h>

#include <Wire.h>

String data;

int count=0;

float i,j;

struct lookUp

{

  String Id;

  char item;

  };

struct lookUp look[4]={{"8906016925268",'T'},{"8901764052279",'C'},{"8902519520197",'L'},{"10014",'M'}};

HX711_ADC LoadCell(3, 6); // parameters: dt pin, sck pin

USB     Usb;

USBHub     Hub(&Usb);

HIDUniversal    Hid(&Usb);

HIDBoot<USB_HID_PROTOCOL_KEYBOARD>    Keyboard(&Usb);

class KbdRptParser : public KeyboardReportParser

{

   void PrintKey(uint8_t mod, uint8_t key);

protected:

  virtual void OnKeyDown  (uint8_t mod, uint8_t key);

  virtual void OnKeyPressed(uint8_t key);

};

void KbdRptParser::OnKeyDown(uint8_t mod, uint8_t key)

{

   uint8_t c = OemToAscii(mod, key);

   if (c)

      {OnKeyPressed(c);

      LoadCell.update();                        // retrieves data from the load cell

      j = LoadCell.getData();}

}


/* what to do when symbol arrives */

void KbdRptParser::OnKeyPressed(uint8_t key)

{


   data+=(char)key;


 };

KbdRptParser Prs;

void setup()

{

   Serial.begin(9600);

   Serial.println("Start");

   LoadCell.begin();                // start connection to HX711

   LoadCell.start(2000);             // load cells gets 2000ms of time to stabilize

   LoadCell.setCalFactor(-80.0);     // calibration factor for load cell => strongly dependent on your individual setup

   if (Usb.Init() == -1)

   {

      Serial.println("OSC did not start.");

   }

   delay( 200 );

   Hid.SetReportParser(0, (HIDReportParser*)&Prs);

   Serial.println("");

   Serial.println("");
```

A.8 Trolley Code



```
/*-------definning Inputs------*/
#define LS 2      // left sensor
#define RS 3      // right sensor

/*-------definning Outputs------*/
#define LM1 4       // left motor
#define LM2 5       // left motor
#define RM1 6       // right motor
#define RM2 7       // right motor
#define E2 10
#define E1  9
struct lookUp
{
  char item;
  int priority;
  };
struct lookUp look[]={{'T',1},{'C',2},{'L',3},{'M',4}};
String data,data1="",data2;
void search(void);
int count3=0;
int quantity[4];
int stops[4];
int count=0;
int no_stops=0;
void moveForward(void);
void turnRight(void);
void turnLeft(void);
void stopThere(void);
void setup()
{
  Serial.begin(9600);
  pinMode(LS, INPUT);    //initializing the pins
  pinMode(RS, INPUT);
  pinMode(LM1, OUTPUT);
  pinMode(LM2, OUTPUT);
  pinMode(RM1, OUTPUT);
  pinMode(RM2, OUTPUT);
  pinMode(E1, OUTPUT);
  pinMode(E2, OUTPUT);

}

void loop()
{
  if (Serial.read()=='@')
  {
      data=Serial.readStringUntil('#');  //receiving data
from the WiFi module
      Serial.println(data);
      count++;
      delay(9000);
 }
  int i,j=0;
 for(j=0;j<4;j++)
 {
  stops[j]=0;                        //assigning stops
  //quantity[j]='0';
    for(i=0;i<data.length();i++)
  {
      if (data[i]==look[j].item)
      {
               stops[j]=1;
              //quantity[j]=data[i+1];
      }
    }
 }
  analogWrite(E1,175);
  analogWrite(E2,175);
  if(digitalRead(LS) && digitalRead(RS))     // Move
Forward
  {
```

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