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Smart Cycle Docking Statoin

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# Abstract

This project aim is to create a cycle docking station which is smart, cost effective, reliable and energy efficient. RFID technology is used to identify and track any cycle near a docking station which has the authorized RFID tag.

UHF RFID tags and readers are used to achieve better detecting range for the station with the use of compatible UHF RFID antennas.

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# Chapter 1: Introduction to Radio Frequency

Radio frequency identification abbreviated as RFID is one of the major technologies used in the world today in the field of security. Even though the technology itself is much older the recent developments in the chip manufacturing are making RFID practical for new applications and settings, particularly consumer item level tagging. These advancements have the potential to revolutionize supply-chain management, inventory control, and logistics.

## Electromagnetic Spectrum

The electromagnetic spectrum is the range of frequencies (the spectrum) of electromagnetic radiation and their respective wavelengths and photon energies.

This frequency range is divided into separate bands, and the electromagnetic waves within each frequency band are called by different names; beginning at the low frequency (long wavelength) end of the spectrum these are: radio waves, microwaves, terahertz waves, infrared, visible light, ultraviolet, X-rays, and gamma rays at the high-frequency (short wavelength) end.

## Radio Frequency

RF is the lowest portion in the electromagnetic spectrum familiar as a medium of analog and modern digital wireless communication system. It spreads in the range between 3 KHz and 300 GHz. All known transmission systems work in the RF spectrum range including analog radio, aircraft navigation, marine radio, amateur radio, TV broadcasting, mobile networks and satellite systems.

Different types of Radio frequencies are as follows:

* Extremely low frequency which ranges from 3Hz to 3KHz and is used in seismic studies
* Very low frequency which ranges from 3KHz to 30KHz and is used in submarines
* Low frequency ranges from 30KHz to 300KHz and one important feature of this range is that it gets reflected by earth’s ionosphere and thus it is useful for long distance communication
* Medium frequency was one of the most popular ranges since the beginning of the wireless radio technology. It operates in the range 300KHz to 3MHz. It is used in many applications including AM radio transmission
* High frequency operates between 3MHz and 30MHz and is mostly used by the aviation industry
* Very high frequency is one of the most commonly used bands which has an operating range from 30 MHz to 300Mhz. It is mostly used in TV broadcasting, medical equipment, amateur radio and military application
* Ultra high frequency is the most important frequency bands for modern wireless communication systems. It ranges from 300 MHz to 3 GHz and is mainly used in GPS navigation systems, satellites, pagers, Wi-Fi, Bluetooth, television broadcasting, and most importantly GSM, CDMA and LTE mobile transmission
* Super high frequency is in the range of 3 GHz to 30 GHz. It can only operate in line of sight path since any obstruction in between the transmitter and receiving station will break the communication. It is commonly used in 5GHz Wifi channel
* Extremely high frequency band is the highest in RF frequency spectrum which range between 30 GHz and 300 GHz. EHF is only used in advanced communication systems due to its complex nature and line of sight requirement. EHF is used in radio astronomy and remote sensing (weather analysis)

# Chapter 2: Radio Frequency Identification

Radio frequency identification abbreviated as RFID is one of the major technologies used in the field of security. Even though the technology is a bit old it is getting popular due to the innovations in the field of chip manufacturing technology.

An RFID system mainly consists of three main components: a scanning antenna, a transceiver and a transponder or also called as an RFID tag. An RFID tag consists of a microchip, memory to store some information and an antenna.

The RFID reader is a network-connected device that can be permanently attached or portable. It uses radio frequency waves to transmit signals that activate the tag. Once activated, the tag sends a wave back to the antenna, where it is translated into data.

There are two main types of RFID tags: active RFID and passive RFID. An active RFID tag has its own power source, often a battery. A passive RFID tag, on the other hand, does not require batteries; rather it receives its power from the reading antenna, whose electromagnetic wave induces a current in the RFID tag's antenna. There are also semi-passive RFID tags, meaning a battery runs the circuitry while communication is powered by the RFID reader.

# Chapter 3: Overview of the system

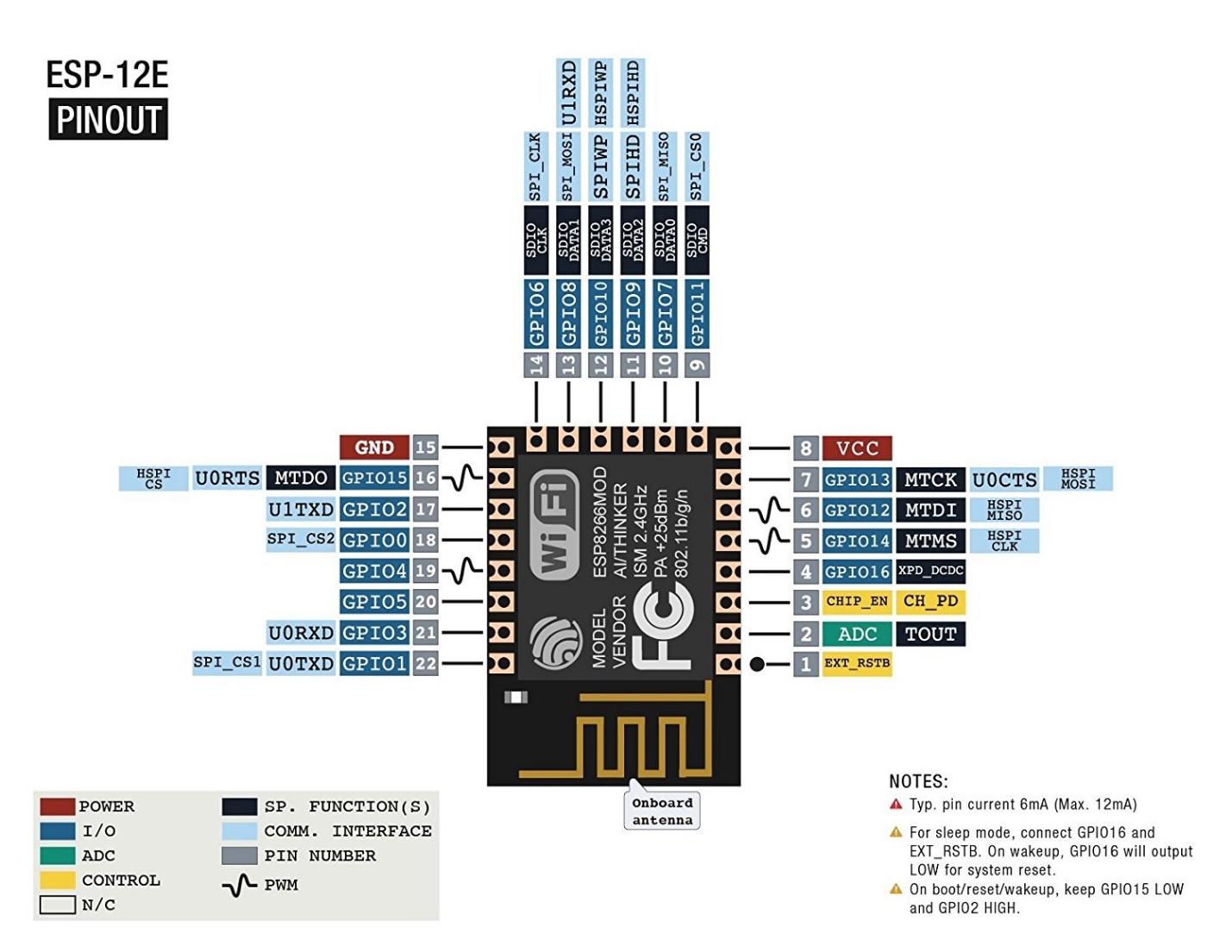
The current system uses UHF RFID readers which are manufactured by Things magic. The tags which are used also works in the UHF range and are passive tags, meaning they do not need any external power to operate. The system also uses an antenna for a better range of communication. The specifications of the antenna are described in the table below. To control and coordinate all the processes a microcontroller board from Espressif Systems called ESP8266-12F is used.

## ESP8266-12F

The ESP8266 is a low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller capability produced by Shanghai-based Chinese manufacturer Espressif Systems. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands.

Features

* Processor: L106 32-bit RISC microprocessor core based on the Tensilica Xtensa Diamond Standard 106Micro running at 80 MHz
* Memory:
  + 32 KiB instruction RAM
  + 32 KiB instruction cache RAM
  + 80 KiB user-data RAM
  + 16 KiB ETS system-data RAM
* External QSPI flash: up to 16 MB is supported (512 KiB to 4 MB typically included)
* IEEE 802.11 b/g/n Wi-Fi
  + Integrated TR switch, bacon, LNA, power amplifier and matching network
  + WEP or WPA/WPA2 authentication, or open networks
* 16 GPIO pins
* SPI
* I²C (software implementation)
* I²S interfaces with DMA (sharing pins with GPIO)
* UART on dedicated pins, plus a transmit-only UART can be enabled on GPIO2
* 10-bit ADC (successive approximation ADC)



## M6E Nano

Embedded UHF RFID Module

ThingMagic Nano delivers the smallest form factor for a Mercury Series embedded UHF RFID module with very low power consumption and is ideal for battery operated, low cost, small form-factor portable readers. ThingMagic Nano’s wide RF output range (0 dBm to +27 dBm) is important for the read/write requirements for RFID-enabled printers and tag commissioning stations. It features a surface mount package designed for the efficiency of SMT manufacturing, driving down the total cost for embedding RFID in volume applications, including handheld devices, consumables authentication, device configuration and access control.

|  |  |
| --- | --- |
| RFID Protocol support | EPCglobal Den 2v2 (ISO 18000-63) |
| Antenna Connector | Single 50 Ohm connection |
| RF Power output | Separate read and write levels, command-adjustable from 0 dBm to +27 dBm in 0.01 dB steps |
| Control/Data Interfaces | UART; 3.3V logic levels 9.6 to 921.6 kbps |
| GPIO Sensors and Indicators | Four 3.3V bidirectional ports configurable as input (sensor) ports or output (indicator) ports |
| DC Power Required | DC Voltage: 3.3 to 5.5 V for +25 dBm out; 3.7 to 5.5 V for +27 dBm out |
| DC power consumption @ RF leve | 3.2 W @ 5 VDC for +27 dBm out |
| Certification | EU (ETSI EN 302 208 v3.1.1, RED 2014/53/EU) |
| Max Read Rate | Up to 200 tags/second |
| Max Tag Read Distance | Over 4.5 meters (15 feet) with 6 dBi antenna (33 dBm EIRP) |
| Operating Temperature | -40°C to +60°C (case temperature) |

*Source : https://www.jadaktech.com/wp-content/uploads/2018/09/Nano-Product-Spec-Sheet-09052018.pdf*

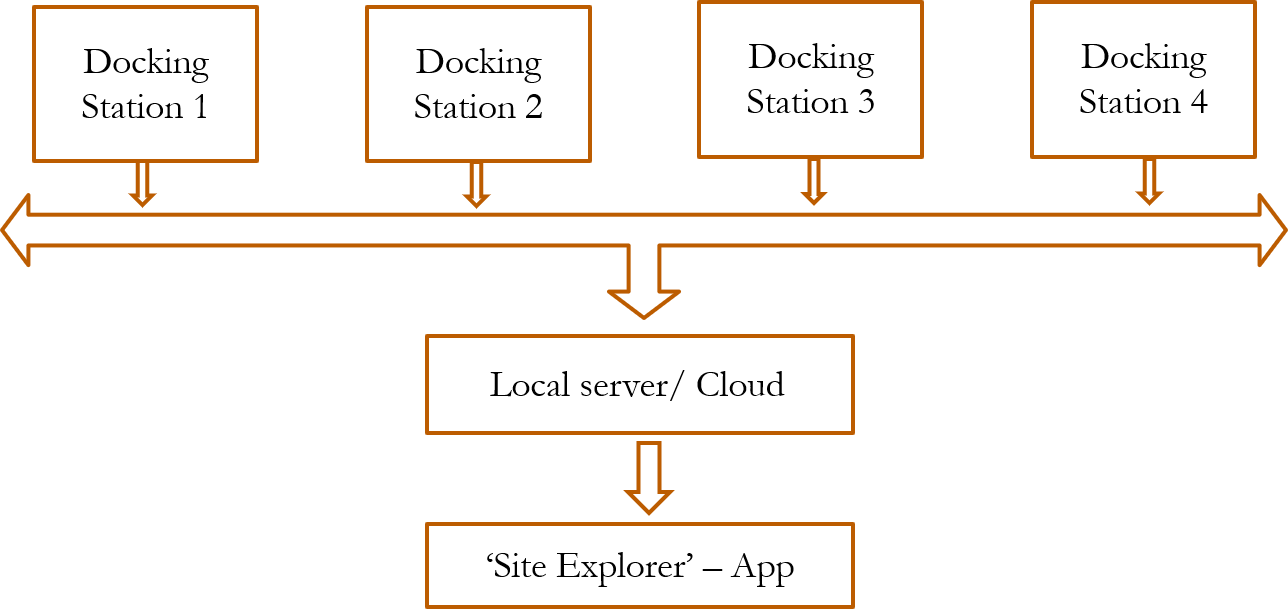
## UHF RFID Antenna

The ultra high-frequency (UHF) RFID Antenna boasts a frequency range of 860-960 MHz with a gain of 6dBi. Each UHF RFID Antenna is terminated with a 30cm long TNC Female RP cable.

Features

* Frequency Range: 860-960 MHz
* Gain: 6 dBi
* VSWR: < 1.6: 1
* Impedance: 50Ω
* Polarization: Linear Vertical
* Antenna Connector: TNC Female RP
* Max Power: 100W
* 223mm x 200mm x 60mm

## High range view of the final system



The final system consists of a finite number of docking stations. These docking stations have their individual RFID receivers, antennas and control modules to transmit the data to the local server/Cloud.

A local server consists of a computer which is used to collect data from all the different docking stations. The data collected is then interpreted and processed according some predefined algorithm and then sent to a remote app to the user.

## Overview of a Docking station

Local Network

ESP8266 Controller

UHF RFID Trans receiver

ANTENNA

## Working of Docking station

Each docking as shown in figure x has a controller and a trans receiver to communicate with the tags which are present in cycles. Antenna is used to improve the range of communication between the tags and the trans receiver.

# Chapter 4: Motion control Tasks

# Chapter 5: Sensor Based Control

# REFERENCES