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Architecture, implementation and application of complex event processing in bus information systems based on Bluetooth.

This report is submitted in accordance with requirement of the University Technical Malaysia Melaka (UTeM) for the Bachelor of Computer Engineering Technology (Computer Systems) with Honors

by

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ABSTRACT

This project is to provide the bus tracking system that monitoring the bus schedule system in the campus. Students can track the bus by using the application and identify the particulars of the buses, such as the bus number and estimated arrival time. With the information, student can reduce the unnecessary waiting time. The main goal of this project is to develop a device that able to send the bus information to user on application. With this system capabilities it can provide the information such as location of bus stop, bus identification, and the estimate arrival time at the bus stop. Bus tracking system have three parts that related terms which software, hardware and application. This project will focus on the hardware part which use the Bluetooth method to collect the data and combination with the controller that control the process of tracking system. This system will work generally through hardware as a transmitter while the software as the receiver, and the application will collect the data through web server. In addition, possible authorities can monitor the bus and also can identify the particulars of the bus such as the bus driver and the bus registration number. This system allows the bus travelling system to be more efficient and user friendly.

ABSTRAK

Projek ini adalah untuk menyediakan sistem pengesan bas yang memantau sistem jadual bas di dalam kampus. Pelajar boleh mendapatkan maklumat bas dengan menggunakan aplikasi dan mengenal pasti butir-butir mengenai bas, seperti nombor bas dan anggaran masa ketibaan. Dengan maklumat ini, pelajar boleh menjimatkan masa menunggu. Matlamat utama projek ini adalah untuk mencipta satu peranti yang boleh menghantar maklumat bas kepada pengguna melalui aplikasi mudah alih. Dengan keupayaan sistem ini, ia boleh memberikan maklumat seperti lokasi perhentian bas, pengenalan bas, dan anggaran masa ketibaan di perhentian bas. Sistem pengesan bus mempunyai tiga bahagian yang berkaitan dengan istilah perisian, perkakasan dan aplikasi. Projek ini akan memberi tumpuan kepada bahagian perkakasan yang menggunakan kaedah sistem Bluetooth untuk mengumpul data dan gabungan dengan peranti pengawal yang mengawal proses sistem pengesanan. Sistem ini akan berfungsi secara amnya melalui perkakasan sebagai pemancar maklumat manakala perisian sebagai penerima, dan aplikasi akan mengambil data melalui pelayan web. Di samping itu, mungkin pihak berkuasa boleh memantau bas dan juga boleh mengenal pasti butir-butir bas seperti pemandu bas dan nombor pendaftaran bas. Sistem ini membolehkan sistem bas perjalanan untuk menjadi lebih cekap dan mesra pengguna.

DEDICATIONS

Alhamdulillah, praise to the Almighty Allah S.W.T

This project is dedicated to:

My parents,

My beloved family,

My Supervisor,

My lecturers,

And all my friends

Thanks for their encouragement and never end support.

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Table of Content

List of Figure

List of Table

List of Abbreviations, Symbols and Nomenclature

A#	-	Analog Pin
AC	-	Alternate Current
ADC	-	Analog to Digital Converter
AT	-	Attention
AVR	-	Alf and Vegard's RISC processor
BT	-	Bluetooth
CR	-	Carriage Return
dBm	-	Decibel-milliWatts
DC	-	Direct Current
D#	-	Digital Pin
EN	-	Enable
GHz	-	Giga Hertz
GIS	-	Geographic Information System
GND	-	Ground
GPIO	-	General Purpose Input Output
GPS	-	Global Positioning System
GPRS	-	General Packet Radio Service
I2C	-	Inter-Integrated Circuit
ID	-	Identification
IDE	-	Integrated Development Environment
IO	-	Input Output

IOREF	-	Input Output Reference
IoT	-	Internet of Things
IP	-	Internet Protocol
ITS	-	Intelligent Transportation System
LED	-	Light Emitting Diode
LF	-	Line Feed
m	-	Meter
mW	-	milliWatts
MISO	-	Multiple Inputs Single Output
MOSI	-	Multiple Outputs Single Input
PCB	-	Printed Circuit Board
PWM	-	Pulse Width Modulation
RFID	-	Radio Frequency Identification
RTC	-	Real Time Clock
RST	-	Reset
RXD	-	Receive Data
SDA	-	Serial Data
SCL	-	Serial Clock
SPP	-	Serial Port Protocol
SS	-	Software Serial
TCP	-	Transmission Control Protocol
TTL	-	Transistor-transistor Logic
TXD	-	Transmit Data
UART	-	Universal Asynchronous Receiver Transmitter
UHF	-	Ultra-High Frequency
USB	-	Universal Serial Bus

CHAPTER 1
INTRODUCTION

This project deals with the implementation of an intelligent bus monitoring system in the campus based on active Bluetooth signal. This project proposes the wireless geolocation transmission data that provides the information about bus id, location bus stop and traveling route. In this system, the information signal will be transmitted and received by the reader when both the devices are in the fixed proximity. Based on that information, this system also has capability to estimate the arrival time of a bus before reach to destination. The first chapter introduces brief idea of the project. It focused on the overview of the project, detailing the objectives, the problem statement, scope and outcome of the project.

1.1 Background

Bluetooth is a wireless technology for exchanging data in short distances using UHF radio waves from 2.3 to 2.485 GHz band from one device to another. It can connect to several devices, overcome the problems of synchronization. This technology uses a radio technology called frequency-hopping spread spectrum. This low energy device transmitted data into packets, and transmits each packet on one of 40 designated Bluetooth channels. Bluetooth is a packet-based protocol with a master-slave structure. One master may communicate with up to seven slaves in a piconet. All devices share the master's clock and for packet exchange based clock.

Bluetooth technology can response to our tracking needs that's why we prefer to used Bluetooth than other technology such as RFID in our design to identify buses arriving and leaving the bus stop. This technology uses a radio technology to wirelessly transfer data from master to slave as identification or tracking. This technology involves the use of master and slave to transmit information. Along with Bluetooth, other sensing technologies such as a RFID, GPS, GPRS, and GIS can be used in a monitoring system. These modules have been integrated together in various studies, and the good results demonstrate that the technologies are compatible.

Bus tracking system studies fall under the category of Intelligent Transportation Systems (ITS), and it's includes a public transportation control framework, road traffic management, and the application of traffic control. There have been a number of previous studies addressing intelligent tracking and monitoring vehicle systems. Intelligent transportation allows various technologies to be applied in transportation systems and it's defined as use information and communication technologies to collect and transmit traffic data to users and operators.

This project will developed an intelligent campus bus identification, monitoring and management system using Bluetooth, Wi-Fi and RTC technologies. The interface algorithm in the control center is able to analyze the location of the bus, information about the bus and the status of the bus, and whether it follows the schedule and the information will be transmitted to the database using Wi-Fi module. Thus, the proposed system should be able to enhance the efficiency of the campus bus system.

1.2 Problem Statement

Normally, everyone is always in hurry to reach their destination. In this case waiting for the buses is not very reliable. People who rely on the public transport has their major concern is to know the current time location of the bus for that they are waiting for and the time it will take to reach at bus stop. This information helps

people in making better traveling decisions. This paper present the major challenges in public transport system and discuss various approaches to intelligently manage it. Bluetooth master device is enabled on the tracking device and search for the slave in between range limit. This system is further integrated with the average of speeds. This is done according to improving the accuracy by including the factors such as volume of traffic, day and time of day. People can track information using smart phone application.

The problems occurring in bus services are to track the bus location, time and unreliable arrival time which may due to unplanned event. The basic purpose of this system is to send bus data to the database when the bus reaches the destination without any conflict of information received. The main problem that must be solved is how to make a device that able to track the bus when it reach the bus stop and transmit the information to the database.

1.3 Project Objective

The objectives of this project are:

1. To develop a device which able to track and transmit the information of bus to system database.
2. To analyze time arrival estimation simulation with actual arrival time.

1.4 Work Scopes

The work scopes are listed to ensure the project is conducted within its intended boundary. Work scope is useful to ensure the project is heading in the right direction to achieve the goal. The work scope for this project is to study about geolocation based on Bluetooth/RFID/GPS, and bus tracking system application from several published papers and books. The main focus on this project is to study the Bluetooth device system for geolocation transmission data with addition of using Arduino module, RTCDS1307 and Wi-Fi module. The parameter for this project has the following features:

- track the bus while arriving at bus stop
- transmit the information of bus to system database

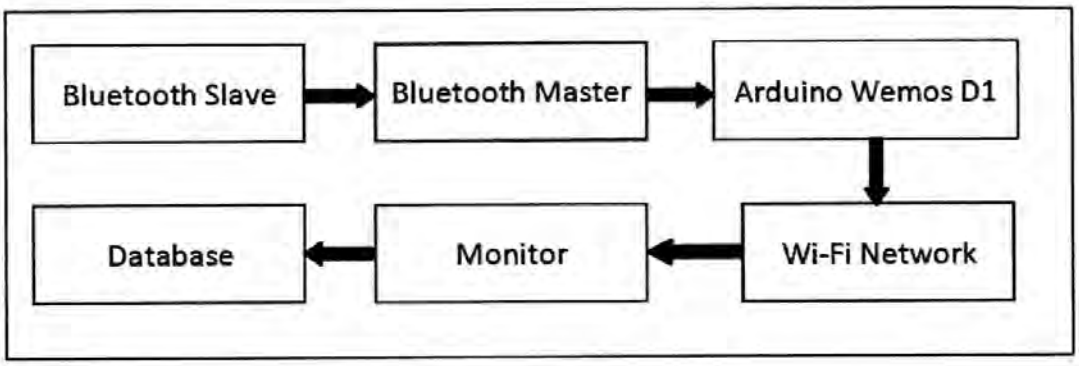

Figure 1.1: Block diagram with proposed system.

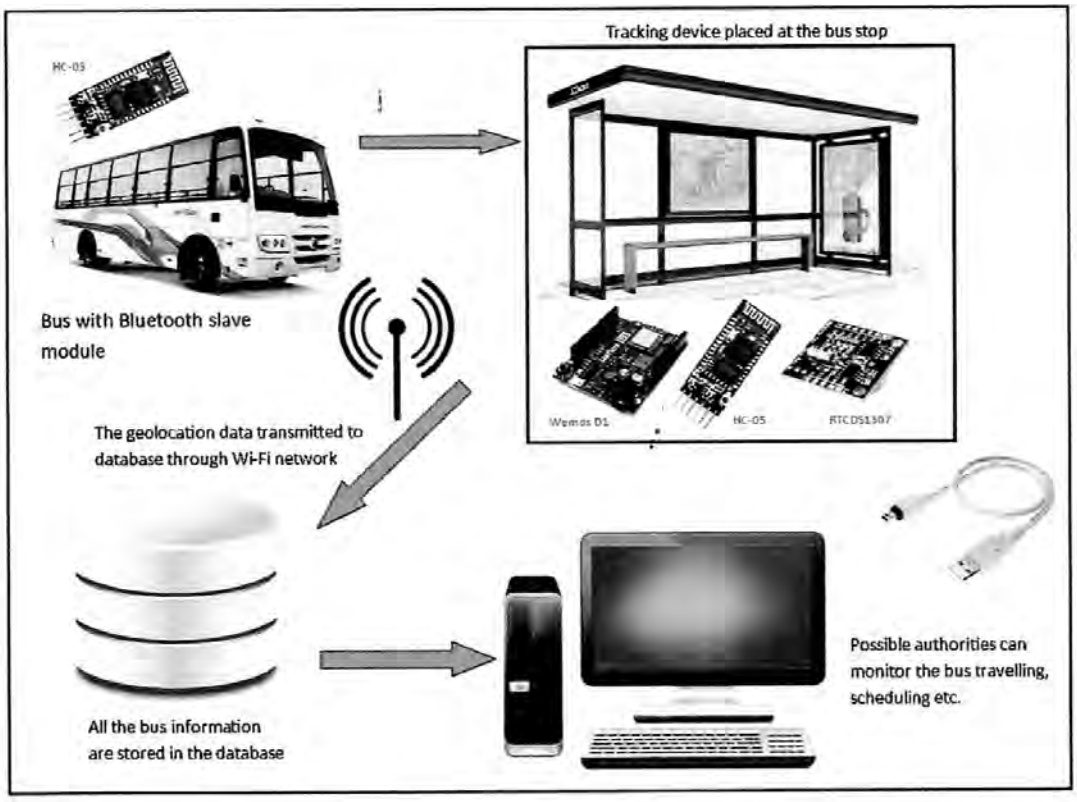

Figure 1.2: Bus tracking system.

CHAPTER 2
LITERATURE REVIEW

In order to make this project successful, some studies and researching has been done. The information and studies for this project was collected from many sources such as books, articles, journals and internet. All this information was used in this project as a guide to make sure this project can be done in the time given. All the studies and information collected was based on major component and topic that related to this project.

2.1 Bus tracking system application

Mobile based Bus Tracking System provides a solution to the problem which helps anyone to retrieve the location of the bus without calling or disturbing the person that travelling in the bus. The person who was boarding the bus and the coordinators of the bus should own an android driven mobile phone with internet connectivity. The Global Positioning System supports in area following with backing of Global Standard for Mobile in cellular telephone to report transport area information again to the servers (Sujatha, K. Nageswara Rao, 2014). Continuously, this shows that the transports are on guide and valuation of entry time and separation with reference to hold stop using gimmicks of Internet. The function of proposed system is to provide an economical, flexible and reliable system for bus tracking.

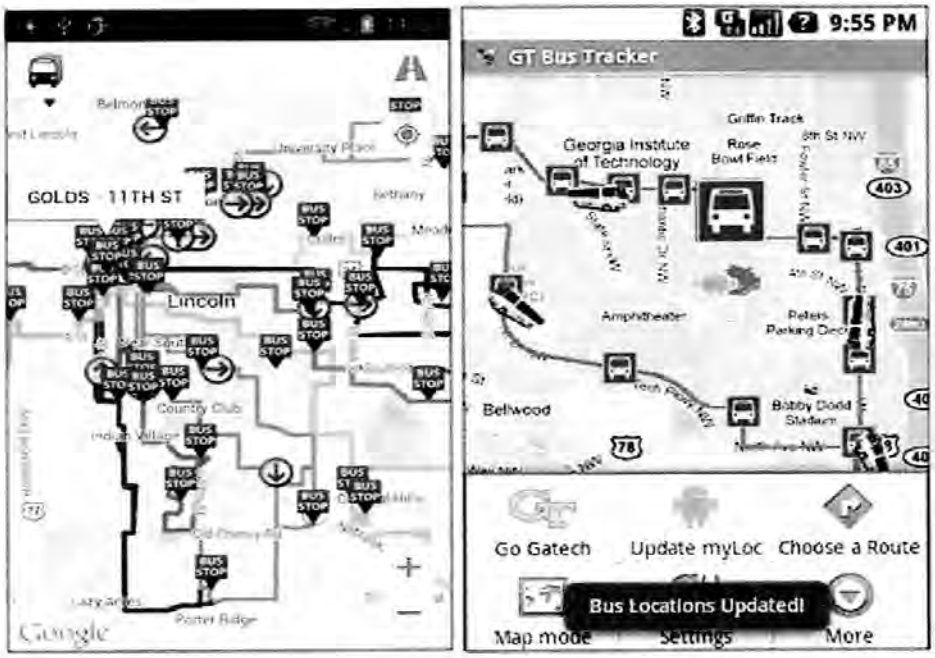

Figure 2.1: Mobile based Bus Tracking System (Network and soft computing (ICNSC), 2014).

RFID is a technology similar to that of bar code scanning. An RFID system consists of tag and reader, where the tag used radio frequency signals to transmit its information to a reader, which usually sends this information to a server that processes it according to the needs of the application. Past research presents a system that can track buses across a city by placing RFID tags in the buses and the readers in every alternative bus stop. The local server for the city received the information of location, and alerts the upcoming bus stop in the route of the bus, of the bus number, route and estimate time of arrival, which are then displayed at the bus stop. This system described as cost effective and easy to implement scheme for tracking buses in real time (V Maria, 2015).

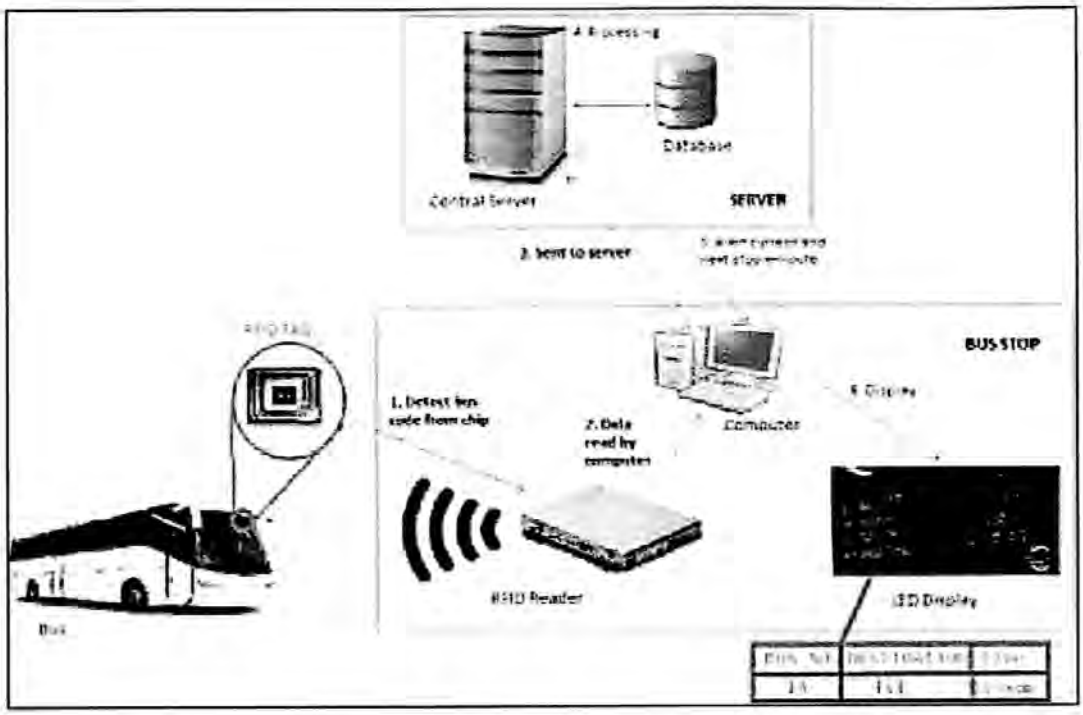

Figure 2.2: Basic element for bus tracking system (International Conference on Innovation Information in Computing Technologies, 2015).

2.2 Bluetooth technology

Bluetooth is a wireless technology for exchanging data in short distances using UHF radio waves from 2.3 to 2.485 GHz band from one device to another. Invented by telecom vendor Ericsson in 1994 and originally conceived as a wireless alternative to RS-232 data cables. Bluetooth technology was developed by Bluetooth Special Interest Group in industry of Mobile personal area network. Bluetooth is a common wire-replacement communications protocol especially designed for low-power consumption, with a short range based on low-cost transceiver microchips. Bluetooth module has 4 classes with different range of communications. Range dependent with power-class and effective ranges vary in practice. Officially class 1 radios have range of up to 100 meters, the longest range for Bluetooth class range and particularly for industrial use cases. Class 2 is most commonly found in mobile

devices, with range approximately 10 meters; follow with class 3 with range of 1 meter. Table 2.1 below shows the class range for Bluetooth device.

Table 2.1: Bluetooth class range.

Class	Max. permitted power		Type of range (m)
	(mW)	(dBm)	
1	100	20	~100
2	2.5	4	~10
3	1	0	~1
4	0.5	-3	~0.5

The effective range varies due to fluctuate conditions, product sample variations, antenna configure and battery condition.

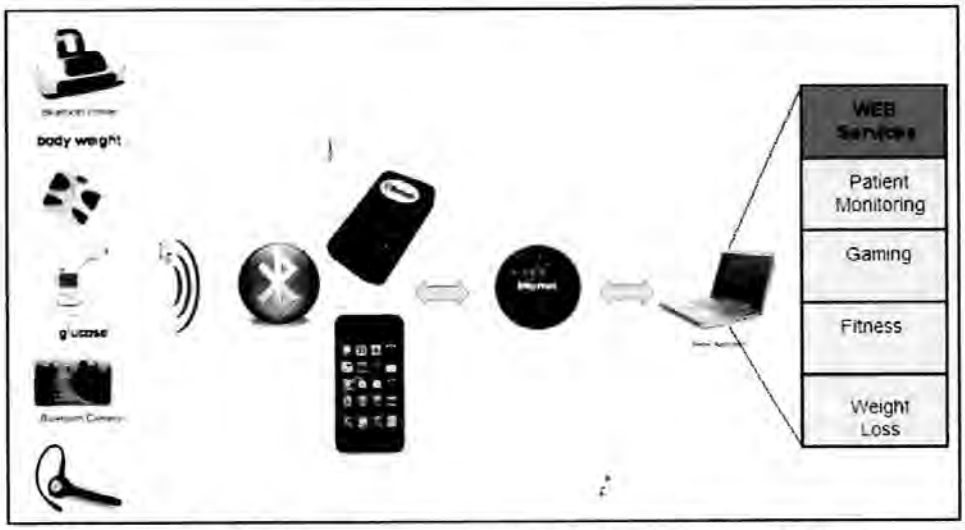

Figure 2.3: Bluetooth communication technology (google.com)

HC-05 Bluetooth modules are based on the Cambridge Silicon Radio BC417 2.4 GHz Bluetooth Radio chip. This Bluetooth Radio chip is a complex microchip which uses an external 8 Mbit flash memory. This Bluetooth module is an easy to use with Bluetooth SPP (Serial Port Protocol) module, designed for wireless serial connection setup. HC-05 can be set up as master or slave and be used in configuration. By default the factory setting is slave. This master and slave role can be configured only by AT Commands. The figure 2.4 below shows list of AT commands for HC-05 Bluetooth module.

AT COMMAND LISTING

	COMMAND	FUNCTION
1	AT	Test UART Connection
2	AT+RESET	Reset Device
3	AT+VERSION	Query firmware version
4	AT+ORGL	Restore settings to Factory Defaults
5	AT+ADDR	Query Device Bluetooth Address
6	AT+NAME	Query/Set Device Name
7	AT+RNAME	Query Remote Bluetooth Device's Name
8	AT+ROLE	Query/Set Device Role
9	AT+CLASS	Query/Set Class of Device CoD
10	AT+IAC	Query/Set Inquire Access Code
11	AT+INQM	Query/Set Inquire Access Mode
12	AT+PSWD	Query/Set Pairing Passkey
13	AT+UART	Query/Set UART parameter
14	AT+CMODE	Query/Set Connection Mode
15	AT+BIND	Query/Set Binding Bluetooth Address
16	AT+POLAR	Query/Set LED Output Polarity
17	AT+PIO	Set/Reset a User I/O pin
18	AT+MPIO	Set/Reset multiple User I/O pin
19	AT+MPIO?	Query User I/O pin
20	AT+IPSCAN	Query/Set Scanning Parameters
21	AT+SNIFF	Query/Set SNIFF Energy Savings Parameters
22	AT+SENM	Query/Set Security & Encryption Modes
23	AT+RMSAD	Delete Authenticated Device from List
24	AT+FSAD	Find Device from Authenticated Device List
25	AT+ADCN	Query Total Number of Device from Authenticated Device List
26	AT+MRAD	Query Most Recently Used Authenticated Device
27	AT+STATE	Query Current Status of the Device
28	AT+INIT	Initialize SPP Profile
29	AT+INQ	Query Nearby Discoverable Devices
30	AT+INQC	Cancel Search for Discoverable Devices
31	AT+PAIR	Device Pairing
32	AT+LINK	Connect to a Remote Device
33	AT+DISC	Disconnect from a Remote Device
34	AT+ENSNIFF	Enter Energy Saving mode
35	AT+EXSNIFF	Exit Energy Saving mode

ERROR CODES

ERROR CODE	VERBOSE
0	Command Error/Invalid Command
1	Results in default value
2	PSKEY write error
3	Device name is too long (>32 characters)
4	No device name specified (0 lenght)
5	Bluetooth address NAP is too long
6	Bluetooth address UAP is too long
7	Bluetooth address LAP is too long
8	PIO map not specified (0 lenght)
9	Invalid PIO port Number entered
A	Device Class not specified (0 lenght)
B	Device Class too long
C	Inquire Access Code not Specified (0 lenght)
D	Inquire Access Code too long
E	Invalid Iquire Access Code entered
F	Pairing Password not specified (0 lenght)
10	Pairing Password too long (> 16 characters)
11	Invalid Role entered
12	Invalid Baud Rate entered
13	Invalid Stop Bit entered
14	Invalid Parity Bit entered
15	No device in the Pairing List
16	SPP not initialized
17	SPP already initialized
18	Invalid Inquiry Mode
19	Inquiry Timeout occured
1A	Invalid:zero lenght address entered
1B	Invalid Security Mode entered
1C	Invalid Encryption Mode entered

Figure 2.4: List of AT command for HC-05 (14core, 2016)

The HC-05 Bluetooth module has 6 pins and 1 button switch. They are EN, VCC, GND, RXD, TXD, and STATE pin. The EN and State pins are rarely use in application. Those pins are described as follows: