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Senior Design Project Report

Autonomous Smart Suitcase

In partial fulfillment of the requirements for the
Degree of Bachelor of Science in Electrical Engineering

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1.1 Abstract

We all know the hassle of pushing along our baggage in the airport. It is a tedious process that aggravates our tiredness and difficulty during the journey. The aim of our project “smart suitcase” is to eliminate the issue of pushing the suitcase around. Not only this will we also be adding additional functionality to the suitcase that will make your suitcase more easy to use and convenient.

This project is selected as the course requirement for “Design methodology” and “Assessment 3” as an attempt to complete the final project requirement. During these two phases the project will go through all the steps of product planning, development and execution.

Autonomous smart suitcase will have features such as autonomous following of the user, bag fall detection and warning, GPS tracking, lost mode and LCD for information display. During the period of the course the project was finalized and specific sub systems were tested as depicted in the report below

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1. Introduction

1.1 1.1 Project Definition

ASS is a smart suitcase that will follow the user wherever he goes. Apart from this it also has additional features such as lost mode, bag fall detection and an LCD to display the user information. The bag will mainly be used by commuters, handicapped people and others in indoor facilities

1.21.2 Project Objectives

ASS will have the following proposed objectives

- Autonomous meal following mode: ensures that the bag follows the user when he or she walks
- Lost mode: With the lost mode the suitcase can be contacted via internet and it sends out the GPS address and automatically plays a buzzer. If the suitcase is nearby it will make a lough sound and display on the LCD details of the owner
- Other features: The suitcase will also have other features such as the following
 - Sensing the orientation using accelerometer

1.31.3 Project Specifications

- Metrics
 - ASS will be powered by a rechargeable 12V lead acid battery
 - Image recognition will enable the bag to follow the user
 - 12V DC motors will be used to power ASS
 - Accelerometer to detect orientation of the bag
 - SIM 900 module to connect to the network
 - 12 V geared dc motors
 - HC 06 for Bluetooth communication with a range of 100 m
- Marketing features
 - The body of ASS will be sturdy and made of rugged material
 - Image recognition sensors will be used as primary technology to enable following the owner of ASS
 - ASS communicates with the user app
 - The Smart suitcase can also be controlled manually using the app
 - Users can turn on lost mode of ASS and the following will be done
 - GPS coordinates are sent
 - A loud pitch sound is made
 - On the suitcase LCD a lost message is displayed

1.41.4 Product Architecture and Components

- Functional diagram

Autonomous smart suitcase is divided into 3 main sub systems as per figure01 so they include the following:

- 1) Subsystem 1: Wireless communication
 - a. GSM
 - b. GPS
 - c. Bluetooth
 - d. Android device
- 2) Subsystem 2: User following
 - a. DC motor
 - b. Motor controller
 - c. Ping transceiver will be replaced by camera
- 3) Subsystem 3: Sensory system
 - a. Buzzer
 - b. LCD
 - c. Gyroscope

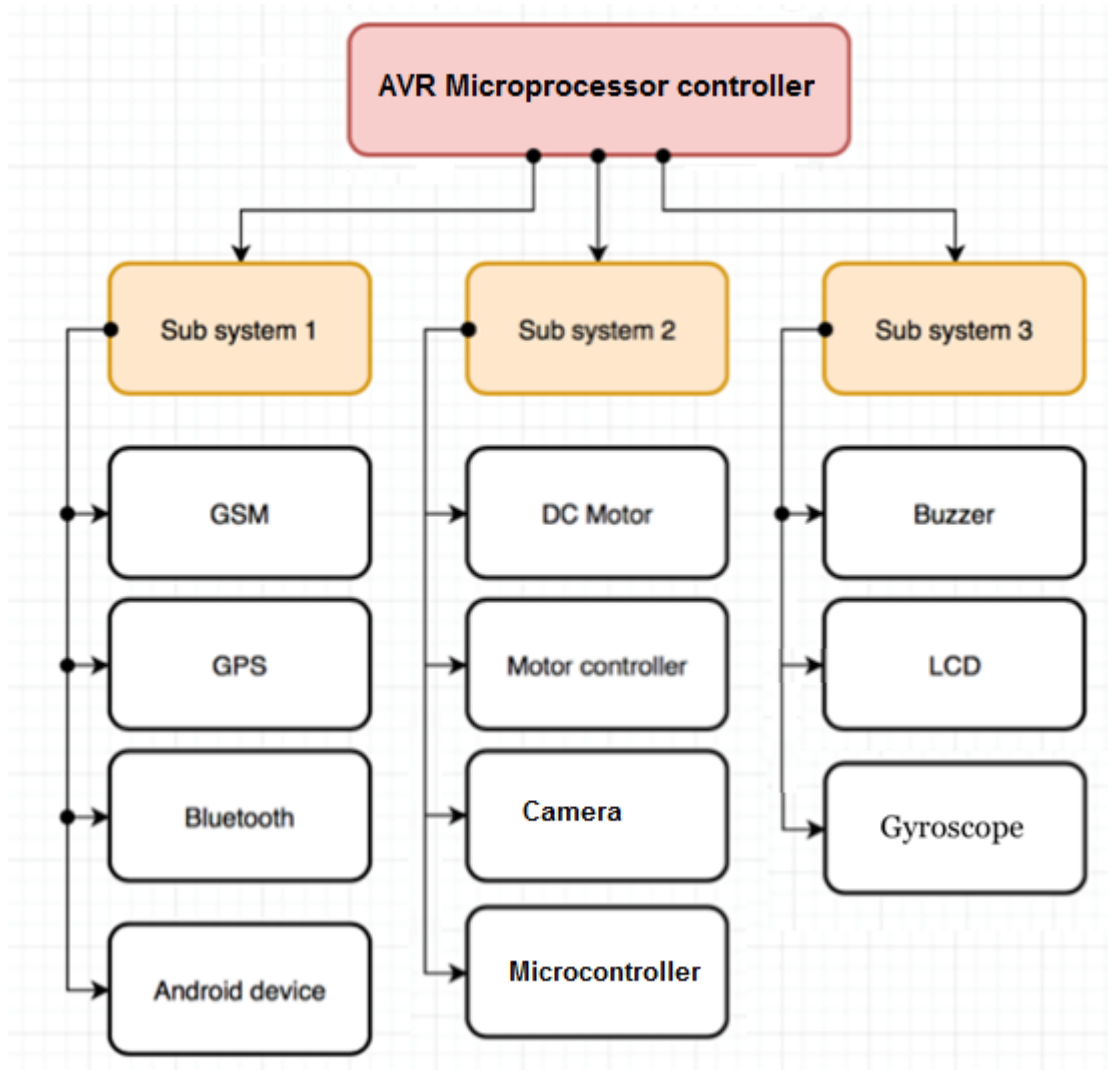


Figure 01: Functional diagram of the project

ASS has been classified into 3 main sub systems to make easy the task of executing the project. Each of this sub system houses under it sensors and modules that relate to it. The AVR controller is a common link between all of the 3 sub systems and is not depicted on the figure above for this reason

1.51.5 Applications

ASS has applications in the following areas:

- Airports as luggage
- Universities
- Hospitals
- Offices
- Other indoor facilities

2. Literature Review

2.12.1 Project background

In a generation where time is the greatest deciding factor, air travel is the most preferred means of transport. Air transport being the fastest means of transport is best suited for long distances travel within minimal time. Airports and airlines are the emerging global companies providing air services. With the added advantages of airlines and airports, travelers face the most common and annoying problem of luggage loss. The loss and mixing of luggage is the most awful experience faced by hundreds of passengers every day. Not much is done in this field to help out the passengers with the problems of suitcase/luggage mixing and loss. To help the travelers we have developed the concept of an intelligent suitcase. This intelligent suitcase is designed with the help of latest technology solving the problems of mixing and loss of suitcases at the airports.

In assistive robotics valuable work has been conducted, specifically for rehabilitation, for example mobility assistance for disabled or elderly people (e.g. smart walkers). Nevertheless, when it comes to outsourcing this kind of task to a robot, humans hand over a considerable amount of responsibility. Hence- forth, it becomes important to trust robots to perform these tasks. Lee and Moray define trust as “the attitude that an agent will help achieve an individual’s goals in a situation characterized by uncertainty and vulnerability” [6], and it is a multi-dimensional concept, inherently complex to measure. Specifically for HRI, evaluating human-robot trust levels has been a challenging and continuously addressed topic [9,16]. In [4] is presented an attempt to quantify the effects of different factors on perceived human-robot trust, showing that robot characteristics (in particular, its performance) influences greatly the perceived trust. Additionally, [2] studied if humans trust a robot to be their partner in a card game scenario. This study showed that although humans trust a robot to partner with them in the card game, those levels of trust are dependent on previous interactions with the same robot. This is what we expect to inform in our hypothesis h1, with users assigning higher levels of trust after interacting with aBag. Moreover, in [2] it was found that because trust is a multifaceted construct, it develops and is expressed differently for humans and robots.

To our knowledge, no other study was performed addressing trust in HRI in an assistive scenario in which the robot carries the belongings of a human.

In such a study, proxemics behavior (the distance the robot would have to the user) becomes a relevant variable to take into account. Different factors have been found to affect HRI proxemics, with studies showing for example that the perceived familiarity with a PR2 robot influences personal space, with people standing closer to the robot when it is perceived as more familiar to them [14]. Another study showed that a more mechanical appearance of the robot seemed to allow people to let the robot come to a closer distance (comparing to a more humanoid one) [13]. When addressing personal space in a social interaction, psychology literature defines four primary zones: intimate, personal, social and public [1]. In a study performed in [5], when people were asked to be followed by a robot the majority of participants preferred to position themselves in a way so that the robot would be in their personal space

(approximately 0.5m to 1.2m). Following this, we would expect that users would also prefer to have aBag with their belongings closer to them, rather than further away. Therefore, for the condition where aBag followed the user closely, the robot moved in the personal zone (0.5m-1.25m), and when aBag moved more freely it situated itself more in the public zone (beyond 3.66m).

2.22.2 Previous Work

Concordia University smart suitcase

- Design robot can track and follow said user while simultaneously avoiding obstacles that may be in its path.
- Wireless technology enables user tracking.

A control system with electrical drive motors to provide the suitcase with autonomous mobility [4]

Pacmule, University of Akron

- Designing and a small model of a smart grid power distribution network. On below figure 02 Wireless connection to the central servers at the utilities. [5]

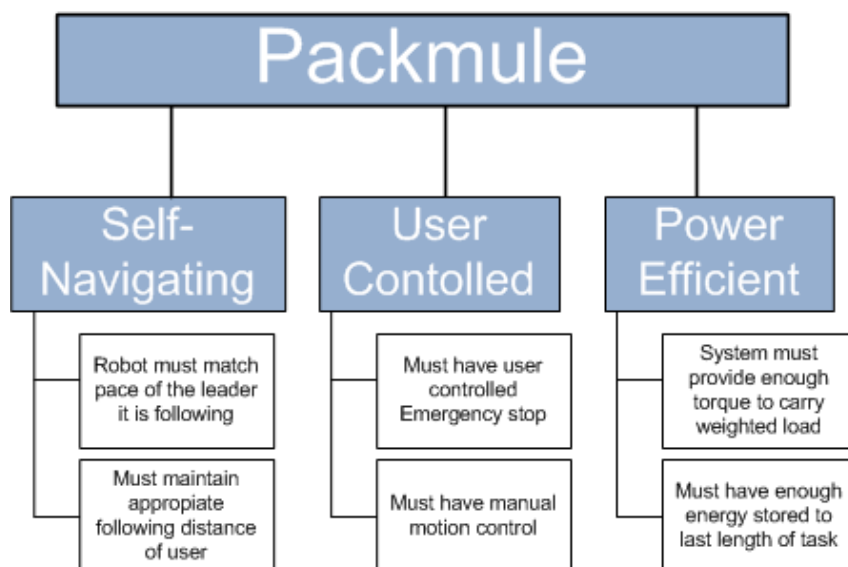


Figure 02: Description of the system designed by AKRON University

Cart-Follow-X1, Simon Fraser University

- Design e design the Cart-Follow-X1 to have three operating modes, “follow”, “assist”, and “manual”.
- Follow - The cart combines it’s dynamic and tracking system to follows its user automatically

- Assist - Motor is on, and assists the user using the cart's dynamic system

Manual - All electronic components are off, user manually maneuvers the cart [6]

Wireless Controlled Luggage Carrier

- To build and demonstrate an autonomous luggage carrying device that follows the operator wirelessly.
- A revolving light mounted on the post will alert other pedestrians of the moving device.
- The stalker will be capable of but not limited to stop and travel in busy lines. It will also be capable of following the user to distant terminals at variable speeds
- The basic design functionality of the stalker entails wireless connectivity to the user. The wireless tethering is accomplished through the use of sensors on a bracelet/strap worn by the user [7]

2.32.3 Comparative Study

Table 01: Summary of literature review compared with our project

Projects	1	2	3	4	Our Project
Weight Scale		NONE			√
Communication Bluetooth, GSM	Bluetooth	Bluetooth		Bluetooth	Bluetooth - GSM
Avoiding Obstacles	√	√	√	√	√
GPS Tracker		NONE			√
portable suitcase	√	√			√
Mobile Application	√	√			√
Follow Users	√	√	√	√	√
LCD + Alert System				Alert System	LCD - Alert System

3. System Design

3.13.1 Design Constraints

3.1.1 Design Constraints: Engineering Standards

The project is divided in to the following sub systems and the related standards are stated:

1. Wireless communication and GPS tracking:
 - a. IEEE 802.15.1 for Bluetooth
2. User following autonomous mode
 - a. NEC 300.22B
3. Sensory sub system and display
 - a. CE
 - b. ROHS

3.1.2 Design Constraints: constraint name

Our project is divided in to the following sub systems and the related constraints are stated:

1. Wireless communication and GPS tracking:
 - a. Social: We need to make sure communication does not take place in the government allotted bands and if we need to communicate in higher frequencies permission is required from CITC
2. User following autonomous mode
 - a. Manufacturability: Since this is a prototype we will not be manufacturing the sensor required for the project
 - b. Image recognition: Image recognition relies on visual data. And hence there are limitations in case the light conditions change drastically
3. Sensory sub system and display
 - a. Economic: there are a wide array of sensors that are available for selection we have selected the ones that are most practical and cost effective

3.2 Design Methodology

This project was divided into 3 main sub systems as seen in figure 3. They are as follows:

- 1) Subsystem 1: Wireless communication
 - a. GSM

- b. GPS
- c. Bluetooth
- d. Android device
- 2) Subsystem 2: User following
 - a. DC motor
 - b. Motor controller
 - c. Ping transceiver will be replaced by camera
- 3) Subsystem 3: Sensory system
 - a. Buzzer
 - b. LCD
 - c. Gyroscope

Each of these sub systems as mentioned in figure 04 under it houses an array of modules and sensors. The main approach to complete this project is to first have a clear project vision and then to divide the system into sub-systems and components. We test each sub system and eventually lead to system integration

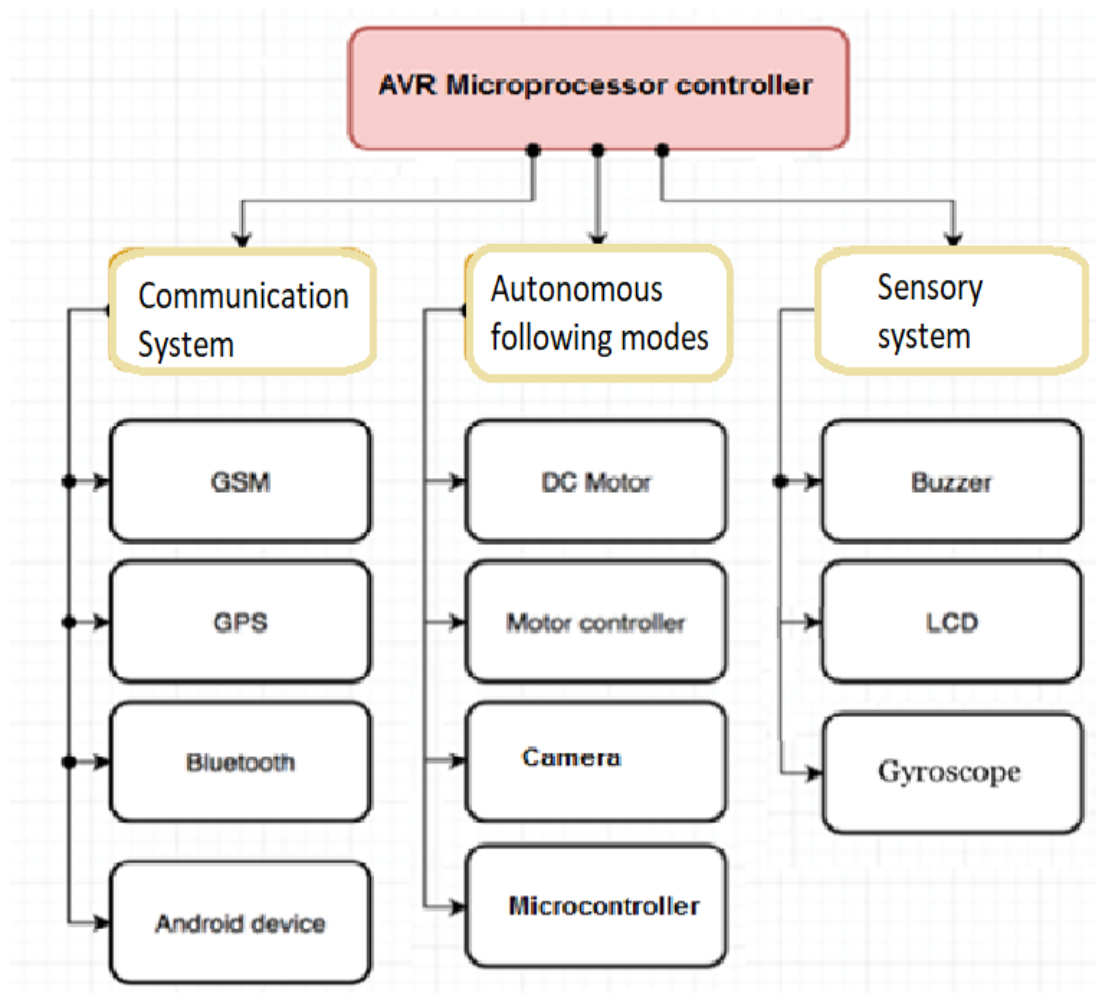


Figure 03: Project architecture

3.3 Product Subsystems and Components

3.3.1 Product Subsystem1: Wireless communication

- ♦ Main functions:
 - ♦ GPRS Communication between bag and the user
 - ♦ GPS signal reception for the bag
 - ♦ Bluetooth connection between user and the bag
- ♦ Hardware used:
 - ♦ SIM 900 GSM chip
 - ♦ NEO 6 GPS chip
 - ♦ HC 05 Bluetooth chip
 - ♦ Android device

3.3.2 Product Subsystem2: User following autonomous mode

- ♦ Main functions:
 - ♦ Follow the user autonomously
 - ♦ Detect if the bag falls down and make a notification
 - ♦ Receive image data using the camera
 - ♦ Detect the user's legs
 - ♦ Move the bag according to the position of the user
 - ♦ Stop if he is very close to the user
- ♦ Hardware used:
 - ♦ DC motor
 - ♦ DC motor controller
 - ♦ Ping transmitter
 - ♦ ping receivers
 - ♦ Camera and processor

3.3.3 Product Subsystem3: Sensory sub system

- ♦ Main functions:
 - ♦ Detect the orientation of the bag using an accelerometer
 - ♦ Play the buzzer in case the bag is lost
 - ♦ Display message in case the bag is lost
- ♦ Hardware used:
 - ♦ Accelerometer
 - ♦ Buzzer
 - ♦ LCD

3.4 Implementation

Sensors and their use

Table 2: Sensors and their functions

Sensor	Use and features
GPS	Used to get the live GPS coordinates
Accelerometer	To get the orientation of the SS
Weight sensor	To measure the weight of the bag
Motor	To move the bag
Bluetooth	To interface with another device and send data
GSM	To send SMS or to connect to the internet
Microcontroller	To program the system and integrate the sensors
LCD	To display mode, address of the owner
Motor controller	To interface between the micro controller and the motor
Ping Transceiver	To send ping from the bag to the user and back. This will help the bag follow user

Justification of sensor use

Table 3: Justification for use of sensors

Sensor	Selected	Justification
GPS	Neo 6m	Can be used with SPI and I2C interface
Accelerometer	ADXL335	Cheap, easy analog output
Weight sensor	Load cell (50kg- max)	Most commonly used weight sensor
Motor	12 V DC	Selected in accordance with weight is specs
Bluetooth	HC-06	Easy interface with AVR chip
GSM	SIM 9000	Cheap, 2G connection
Microcontroller	Atmel 328	Easy to deal with AVR controller
LCD	16X2 Backlight	Rugged and inexpensive
Motor controller	293d motor driver	Most ideal for the application

Component selection: GPS

Table 4: GPS sensor selection

No	Component	Availability	Cost	Compatibility	Size	Difficulty (Connecting, interfacing, testing)	Selected
1	NEO 6M	Local	80 Sr	Yes	6X3 Cm	Moderate	YES
2	GPS 11058	Sparkfun.com	240 Sr	Yes	5X3 Cm	Moderate	NO

Component selection: GSM

Table 5: GSM sensor selection

No	Component	Availability	Cost	Compatibility	Size	Difficulty (Connecting, interfacing, testing)	Selected
1	SIM 900	Local	320 Sr	Yes (Needs external power also)	6X6 Cm	Hard (No support)	YES
2	Arduino GSM shield	Local	550 Sr	Yes	5X3 Cm	Moderate	NO
3	TC-35 Siemens	Online order	350 Sr	Yes but difficult (No library)	6X6 Cm	Very Hard	NO

Component selection: Weight sensor

Table 6: : Weight sensor selection (Not used to reduce complexity)

No	Component	Availability	Cost	Compatibility	Benefit	Difficulty (Connecting, interfacing, testing)	Selected
1	Load cell	Local	80 Sr	Yes(But needs a sub circuit)	Accurate, upto 50 Kg	Moderate	YES
2	Resistive pressure sensor	Sparkfun.com	100 Sr	Yes(Needs to be connected in voltage divider configuration)	Not accurate, upto 8 Kg	Moderate	NO

Component selection: LCD

Table 7: LCD selection

No	Component	Availability	Cost	Compatibility	Difficulty (Connecting, interfacing, testing)	Size	Selected
1	LCD 16 X 2	Local	80 Sr	Yes	Moderate	8 X 4 Cm	YES
2	LCD 20 X 4	Not Available	200 Sr	Yes	Moderate	12 X 6 Cm	NO

Component selection: Motor

Table 8: motor selection

No	Component	Availability	Cost	Compatibility	Benefit	Difficulty	Selected
1	Gear Stepper motor	Local	85 Sr	Yes but needs a driver	Very accurate steps	Moderate	NO
2	Geared DC motor 12 V	Local	250Sr	Yes also needs a driver	High torque	Moderate	YES

Component selection: Motor controller

Table 9: Motor controller selection

No	Component	Availability	Cost	Compatibility	Benefit	Difficulty (Connecting, interfacing, testing)	Selected
1	Arduino motor shield	Local	150 Sr	Yes	Easy to use (Readymade code in IDE)	Easy	YES
2	L298N With heat sink	Local	80 Sr	Yes	Cheap and affective	Moderate	YES

Component selection: Accelerometer

Table 10: Accelerometer selection

No	Component	Availability	Cost	Compatibility	Benefit	Difficulty	Selected
1	ADXL3XX	Online	70 Sr	Yes	Ease of use	Easy	NO
2	MPU-6050 Accelerometer + Gyro	Local	120 Sr	Yes	Single chip has both gyro and accelerometer	Hard (Uses I2C interface)	YES

Component selection: User following

Ping transceivers component was discontinued in the project because it was not ideal to achieve the line following

Table 11: User following sensor selection

No	Component	Availability	Cost	Compatibility	Benefit	Difficulty	Selected
1	Ping sensors	Local	200 Sr	YES	Cheap, Easy to test proof of concept	Hard	YES
2	Camera (Pixy cam)	Online	80 USD	YES	Fast but object must be within field of vision of camera	Hard	YES
3	IR	Local	80 Sr	YES	Cheap but, The transmission beam of the transmitter must be narrowed	Hard	NO
4	Lazer	Local	50 Sr	YES	Cheap but can be very inaccurate	Hard	NO

4. System Testing and Analysis

4.1 Subsystem 1: Wireless communication and GPS tracking

GPS test

Table 12: GPS test criteria

No	Test conditions	Difficulty faced or notes	Test result
1	Done in an area with good signal coverage for "Zain"	Jumper pins of the module were confusing	An SMS was successfully sent at the end
2	Communication was done at 9600 baud	Module needs to be switched on physically each time	
3	A zain sim card was used	Module needs 1 A external power supply each time	

Bluetooth test

Table 13: Bluetooth test criteria

No	Test conditions	Difficulty faced or notes	Test result
1	Baud rate for communication at 9600	Tx of Bluetooth must be connected to Rx of Arduino and	Data was successfully sent from Arduino and received on the android device
2	ASCII(Keyboard characters) are sent and received	Rx of Bluetooth must be connected to Tx of Arduino and	Data was successfully sent from Android device and received on the Arduino
3	Android device is used to pair	There should be software delay in transmission to avoid overload	
4	Backlight of LCD is powered	Any pins can be used for transmission on the arduino by using "Software serial"	
5	Android 6.0 version is used		

Image recognition test

Table 14: Image recognition test criteria

No	Test conditions	Difficulty faced or notes	Test result
1	Baud rate for communication at 9600	Detection of signatures was difficult to setup	Detection pattern was set on the image processor
2	ASCII(Keyboard characters) are sent and received	It was difficult to send data to Arduino. As the right interface had to be set (I2C not SPI)	Data was successfully sent from image processor and received on the Arduino
3	Pixy cam is used	Camera needed white balancing	Image processor was able to detect pattern
4	I2C port connection made from controller to camera	I2C communication between Arduino and image processor	
5	Camera software downloaded		

4.2 Subsystem 2: User following autonomous mode

Motor test

Table 15: Motor test criteria

No	Test conditions	Difficulty faced or notes	Test result
1	12 V DC supply is used	Initial setup was difficult	Motor was successfully controlled
2	The speed is set to max in the program		
3	No load is connected to the motor		

4.3 Subsystem 3: Sensory sub system

LCD and servo test

Table 16: LCD and servo test criteria (Servo not used)

No	Test conditions	Difficulty faced or notes	Test result
1	12 V DC supply is used	Multiple wires for LCD make setup a little difficult	Sample data was successfully displayed
2	No load is connected to servo		Servo was tested for 180 degree sweep
3	LCD contrast is set to 2.5 V		
4	Backlight of LCD is powered		

4.3 Overall Results, Analysis and Discussion

Overall the various sensors were tested for each of the sub-systems and the outcome has varied. We have ensured that all the sensors work individually and none of them are faulty, no quantitative data was collected during the tests to be represented in tables

5. Project Management

5.1 Project Plan

We will define how this project will be completed in 2 phases

Phase 1

- Finalize the teams
- Literature review of the project
- Analyze the possible components
- Select the components and order
- Test each component as it arrives
- Design sub system 1
- Design sub system 2

Phase 2

1. Design sub system 3
2. Mainly the integration the system, LCD
3. 4G/3G connectivity and GPS tracking
4. Test and analyze all the sub systems separately
5. Write a final report and presentation

5.2 Contribution of Team Members

Table 17: Task distribution

Task	Ali	Fawaz	Nasser	Abdurrahman	Task Total
Search & acquire components	20%	30%	25%	25%	100%
Design Subsystems	20%	35%	25%	20%	100%

Test Subsystems	25%	40%	10%	25%	100%
Write Reports & Presentations	20%	45%	25%	10%	100%

5.3 Project Execution Monitoring

- ♦ **Group meeting times:**

2 Times in a week for 2 hours

- ♦ **Advisor meeting intervals:**

Once every 2 weeks

5.4 Challenges and Decision Making

- ♦ Main challenges

- ♦ GSM Chip was very confusing to program

- ♦ User following mode could not be completed using the previously proposed method

- ♦ The GPS requires LOS (Line of sight) and does not work indoor

- ♦ Main challenges overcome

- ♦ User following mode: The ping transmitters that ere proposed earlier were not achieving this functionality. An alternative method was used and this was completed using image recognition

5.5 Project Bill of Materials and Budget

Table 18: Project costs

No	Item	Cost
1	Arduino	100
2	LCD	120
3	Project chassis	400
4	Motor controller	100
5	GPS	3000
6	Motors	1000
7	Ultra Sonic sensors	300
8	Android phone	1000
9	GSM Module	1000
10	Accelerometer	100
11	HC 05 Bluetooth	100
Total		7220 SR

6 Project Analysis

In this section, you will analyze your project in terms of the following:

6.1 Life-long Learning

This list includes the new skills gained during the project. It should be taken note that this is the first phase of the project and on project completion far greater skills will be acquired

- New hardware devices (such as Sim 900 module, accelerometer, motor and controller)
- New software tools (such as Arduino IDE),
- Project management skills
- Image recognition
- Seeking alternative solutions
- Mitigating major issues
- Time management skills
- Teamwork
- Professionalism

6.2 Impact of Engineering Solutions

Our project helps the society in the following ways

- ♦ Makes life easy for commuters
- ♦ Helps the handicapped and less privileged
- ♦ Reduces loss of baggage
- ♦ Provides peace of mind and assurance

6.3 Contemporary Issues Addressed

Our project is in line with the following contemporary issues

- ♦ Helping those in need
- ♦ In line with the new Saudi vision 2030

7. Conclusions and Future Recommendations

7.1 Conclusions

The project objectives were met at the completion. This was not an easy task and required a lot of effort from all members of the group. The main challenge was to achieve the line following mode. This project was very unique because it used image recognition for the user following mode. After having completed this project we have learnt a lot of skills that will enable us tackle more real world engineering projects in the future

7.2 Future Recommendations

It is a great achieve for the team to have completed this project. At the proposal stage to achieve autonomous following something unreal and difficult. Having achieved this we are confident going ahead. However these changes can be made for project improvement.

- ♦ Install smaller motors
- ♦ Use Bluetooth for user following
- ♦ Use AI to improve the bag and learn from its mistakes
- ♦ Develop an indoor navigation system for the bag
- ♦ Add a load cell to measure weight
- ♦ Improve the speed function of ASS during activating of autonomous following mode.
- ♦ Add battery charger and USB port to be used for any smart phone device and personnel laptop.

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23. Wireless Controlled Luggage Carrier, Florida Atlantic University, 2011

Appendix A: Progress Reports

Tasks		Description (brief but clear)	Date	% Completion
Completed Weeks 1 to 6	1	Finished SS2a: Motor installation on the bag		100%
	2	Finished SS2c: Test the ping transceivers and user following capability		80%
	3	Finished SS1c: Test the Bluetooth interface and ensure workability		100%
	4	Worked on SS1a: Enable the system to have lost mode by sending it an SMS		70%
In Progress Weeks 7 & 8	5		40%
	6			20%
	7			...
Comments	We are currently on track with the plan and are now testing the sensors for the following mode. Which is expected to be the last major hurdle in the project			
Deadlines Thu	ProgRpt1 (Wks 1- 6) Th Oct 11			ProgRpt3 (Wks 9, 10) Th Nov 8
	ProgRpt2 (Wks 7, 8) Th Oct 25			ProgRpt4 (Wks 11, 12) Th Nov 22


Tasks		Description (brief but clear)	Date	% Completion
Completed Weeks 1 to 6	1	Finished SS2a: Motor installation on the bag		100%
	2	Finished SS2c: Test the ping transceivers and user following capability		80%
	3	Finished SS1c: Test the Bluetooth interface and ensure workability		100%
	4	Worked on SS1a: Enable the system to have lost mode by sending it an SMS		70%
In Progress Weeks 7 & 8	5	Install SS3c and test		100%
	6	SS2: Installed ping sensors and test with motors		100%
	7	SS3a: Installed buzzer		100%
	8	SS3a: Integrate buzzer, SS3c		80%

Comments	We were not able to achieve following using the ping sensors. Now we will be using the camera to achieve the same		
Deadlines Thu	ProgRpt1 (Wks 1- 6) Th Oct 11		ProgRpt3 (Wks 9, 10) Th Nov 8
	ProgRpt2 (Wks 7, 8) Th Oct 25		ProgRpt4 (Wks 11, 12) Th Nov 22

Tasks		Description (brief but clear)	Date	% Completion
Completed Weeks 7 to 8	1	Install SS3c and test		100%
	2	SS2: Installed ping sensors and test with motors		80%
	3	SS3a: Installed buzzer		100%
	4	SS3a: Integrate buzzer, SS3c		70%
In Progress Weeks 9 & 10	5	Install software for image recognition		100%
	6	Tidy up wiring within the bag		100%
	7	Install the camera in the bag		100%
	8	Receive camera feed		80%
	9	Program system to detect objects		
Comments	We were not able to achieve following using the ping sensors. Now we will be using the camera to achieve the same			
Deadlines Thu	ProgRpt1 (Wks 1- 6) Th Oct 11		ProgRpt3 (Wks 9, 10) Th Nov 8	
	ProgRpt2 (Wks 7, 8) Th Oct 25		ProgRpt4 (Wks 11, 12) Th Nov 22	

Tasks		Description (brief but clear)	Date	% Completion
Completed Weeks 7 to 8	1	Tidy up wiring within the bag		100%
	2	Install the camera in the bag		80%
	3	Receive camera feed		100%
	4	Program system to detect objects		70%
In Progress Weeks 9 & 10	5	Paint the support bar		100%
	6	Install camera API		100%
	7	Receive coordinates from the image detection		100%
	8	Integrate motor and received camera		80%
	9	Adjust framerate of the camera		80%


Comments	We were not able to achieve following using the ping sensors. Now we will be using the camera to achieve the same		
Deadlines Thu	ProgRpt1 (Wks 1- 6) Th Oct 11		ProgRpt3 (Wks 9, 10) Th Nov 8
	ProgRpt2 (Wks 7, 8) Th Oct 25		ProgRpt4 (Wks 11, 12) Th Nov 22

	Project Management: Progress Report	
	Electrical Engineering Department	
EEEN4311: Design Methodology & Project Management (Spring 2018)		
Weeks 1-6	Progress Report No. 1	Date: March 4, 2018

Project Title	Autonomous Smart Luggage
----------------------	---------------------------------


Tasks	Description (brief but clear)	% Completion	
Completed Weeks 1 to 6	1	Background research and reading about other projects that have a following concept using ping transceivers	100%
	2	Search for components and resources in the local market (such as existing sensors in the market, Advise from PMU instructors)	100%
	3	Prepared project proposal and project plan	100%
	4	Preparation of mid term presentation	60%
	5	Search for circuits and components to implement subsystem (Load cell, accelerometer).	100%
	6	Created the project architecture and identified the sub-systems	100%
In Progress Weeks 7 & 8	7		
	8		
	9		
Comments	Comment on any reason for delays or challenges met and mention any decision taken.		

Deadlines	ProgRpt1 (Weeks 1- 6) Due March 4	ProgRpt3 (Weeks 7, 10) Due April 1st
	ProgRpt2 (Weeks 7, 8) Due March 18	ProgRpt4 (Weeks 11, 12) Due April 15
File naming: Submit via email & copy all team members & Advisor: e.g. DM_ProgRpt1_Nomad_Rover		

	Project Management: Progress Report	
	Electrical Engineering Department	
	EE4311: Design Methodology & Project Management (Spring 2018)	
Weeks 1-6	Progress Report No. 1	Date: March 4, 2018
Project Title	Autonomous Smart Luggage	


Tasks	Description (brief but clear)	% Completion	
Completed Weeks 1 to 6	1	Background research and reading about other projects that have a following concept using ping transceivers	100%
	2	Search for components and resources in the local market (such as existing sensors in the market, Advise from PMU instructors)	100%
	3	Prepared project proposal and project plan	100%
	4	Preparation of mid term presentation	100%
	5	Search for circuits and components to implement subsystem (Load cell, accelerometer).	100%
	6	Created the project architecture and identified the sub-systems , Create progress report 1	100%
In Progress Weeks 7 & 8	7	Purchase GSM Module, accelerometer, micro controller, motor controller, trolley bag	100%
	8	Read documentation of the GSM module	100%
	9	Test the GSM module (Faced difficulty: The module needed more power so we used external supply)	100%

	10	Test the accelerometer	100%
	11	Make markings on the trolley for placement of components	60%
Comments	Comment on any reason for delays or challenges met and mention any decision taken.		
Deadlines	ProgRpt1 (Weeks 1- 6) Due March 4		ProgRpt3 (Weeks 7, 10) Due April 1 st
	ProgRpt2 (Weeks 7, 8) Due March 18		ProgRpt4 (Weeks 11, 12) Due April 15
File naming: Submit via email & copy all team members & Advisor: e.g. DM_ProgRpt1_Nomad_Rover			

	Project Management: Progress Report	
	Electrical Engineering Department	
EN4311: Design Methodology & Project Management (Spring 2018)		
Weeks 1-6	Progress Report No. 1	Date: March 4, 2018
Project Title	Autonomous Smart Luggage	

Tasks	Description (brief but clear)	% Completion	
Completed Weeks 9 to 10	1	Purchase the DC motor	100%
	2	Select DC motor controller according to specs and buy	100%
	3	Prepare and give the mid-term exam	100%
	4	Purchase the LCD, controller (used as transmitter)	100%
	5	Test the Bluetooth chip for serial communication	100%
	6	Test the DC motor	0%
In Progress Weeks 11 & 12	7		
	8		
	9		
	10		
	11		

Comments	Comment on any reason for delays or challenges met and mention any decision taken.	
Deadlines	ProgRpt1 (Weeks 1- 6) Due March 4	ProgRpt3 (Weeks 7, 10) Due April 1st
	ProgRpt2 (Weeks 7, 8) Due March 18	ProgRpt4 (Weeks 11, 12) Due April 15
File naming: Submit via email & copy all team members & Advisor: e.g. DM_ProgRpt1_Nomad_Rover		

	Project Management: Progress Report	
	Electrical Engineering Department	
	EE4311: Design Methodology & Project Management (Spring 2018)	
Weeks 1-6	Progress Report No. 1	Date: March 4, 2018

Project Title	Autonomous Smart Luggage
----------------------	---------------------------------

Tasks	Description (brief but clear)	% Completion	
Completed Weeks 9 to 10	1	Purchase the DC motor	100%
	2	Select DC motor controller according to specs and buy	100%
	3	Prepare and give the mid-term exam	100%
	4	Purchase the LCD, controller (used as transmitter)	100%
	5	Test the Bluetooth chip for serial communication	100%
	6	Test the DC motor	0%
In Progress Weeks 11 & 12	7	Motor testing complete	
	8	Print on the LCD	
	9	Start preparation of the final report	
	10	Install the accelerometer in the bag	
	11		
Comments	Comment on any reason for delays or challenges met and mention any decision taken.		
Deadlines	ProgRpt1 (Weeks 1- 6) Due March 4	ProgRpt3 (Weeks 7, 10) Due April 1st	
	ProgRpt2 (Weeks 7, 8) Due March 18	ProgRpt4 (Weeks 11, 12) Due April 15	

Appendix B: Bill of Materials

Table 19: Project component cost

No	Item	Cost
1	Arduino	100
2	LCD	120
3	Project chassis	400
4	Motor controller	100
5	GPS	3000
6	Motors	1000
7	Ultra Sonic sensors	300
8	Android phone	1000
9	GSM Module	1000
10	Accelerometer	100
11	HC 05 Bluetooth	100
Total		7220 SR

Appendix C: Datasheets

Technical Specification

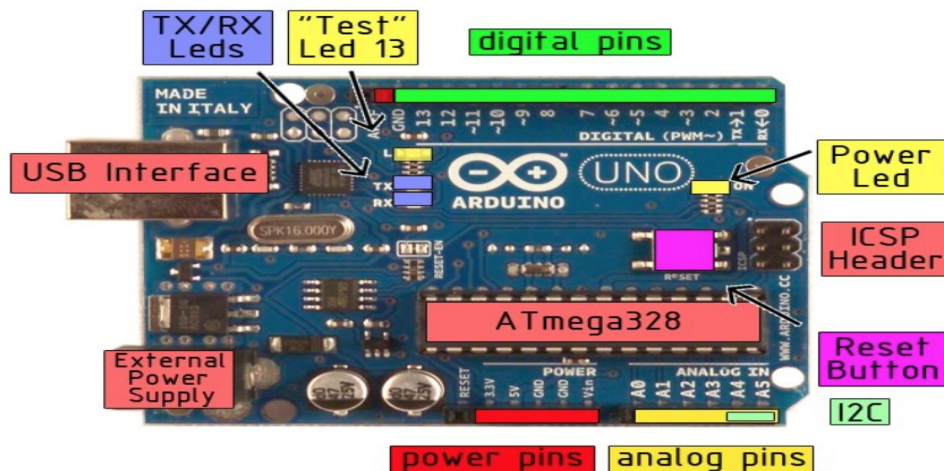


EAGLE files: [arduino-duemilanove-uno-design.zip](#) Schematic: [arduino-uno-schematic.pdf](#)

Summary

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	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB of which 0.5 KB used by bootloader
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16 MHz

the board



Appendix D: Program Codes

3.5GPS

```
#include <SoftwareSerial.h>
```

```
SoftwareSerial GPRS(7, 8); //7 = TX, 8 = RX
```

```
unsigned char buffer[64]; port
```

```
int count=0;
```

```
int i = 1; //if i = 0, send SMS.
```

```
void setup(){
```

```
  //delay(10000);
```

```
  GPRS.begin(19200); // the GPRS baud rate
```

```
  Serial.begin(19200); // the Serial port of Arduino baud rate.
```

```

Serial.print("I'm ready");
Serial.print("Hello?");
}

void loop(){
  if (GPRS.available()){      // if data is coming from softwareserial port ==> data is
    coming from gprs shield

    while(GPRS.available()){  // reading data into char array
      buffer[count++]=GPRS.read(); // writing data into array
      if(count == 64)break;
    }
    Serial.write(buffer,count); // if no data transmission ends, write buffer to
    hardware serial port
    clearBufferArray();       // call clearBufferArray function to clear the stored
    data from the array
    count = 0;                // set counter of while loop to zero
  }

  if (Serial.available())     // if data is available on hardwareserial port ==> data is
    coming from PC or notebook
    GPRS.write(Serial.read()); // write it to the GPRS shield
  if(i == 0){
    GPRS.print("AT+CMGF=1\r"); //sending SMS in text mode
    Serial.println("AT+CMGF=1\r");
    delay(1000);
    GPRS.print("AT+CMGS=\"+554988063979\"\r"); // phone number
    Serial.println("AT+CMGS=\"+554988063979\"\r");
    delay(1000);
    GPRS.print("Test\r"); // message
    Serial.println("Test\r");
    delay(1000);
    GPRS.write(0x1A); //send a Ctrl+Z(end of the message)
    delay(1000);
    Serial.println("SMS sent successfully");
    i++;
  }
}

void clearBufferArray(){      // function to clear buffer array
  for (int i=0; i<count;i++){
    buffer[i]=NULL;          // clear all index of array with command NULL
  }
}

```

3.6 Accelerometer

```

/*
ADXL3xx

```

Reads an Analog Devices ADXL3xx accelerometer and communicates the

acceleration to the computer. The pins used are designed to be easily compatible with the breakout boards from SparkFun, available from: <http://www.sparkfun.com/commerce/categories.php?c=80>

The circuit:

- analog 0: accelerometer self test
- analog 1: z-axis
- analog 2: y-axis
- analog 3: x-axis
- analog 4: ground
- analog 5: vcc

created 2 Jul 2008
by David A. Mellis
modified 30 Aug 2011
by Tom Igoe

This example code is in the public domain.

```
http://www.arduino.cc/en/Tutorial/ADXL3xx
*/

// these constants describe the pins. They won't change:
const int groundpin = 18;      // analog input pin 4 -- ground
const int powerpin = 19;      // analog input pin 5 -- voltage
const int xpin = A3;          // x-axis of the accelerometer
const int ypin = A2;          // y-axis
const int zpin = A1;          // z-axis (only on 3-axis models)

void setup() {
  // initialize the serial communications:
  Serial.begin(9600);

  // Provide ground and power by using the analog inputs as normal digital pins.
  // This makes it possible to directly connect the breakout board to the
  // Arduino. If you use the normal 5V and GND pins on the Arduino,
  // you can remove these lines.
  pinMode(groundpin, OUTPUT);
  pinMode(powerpin, OUTPUT);
  digitalWrite(groundpin, LOW);
  digitalWrite(powerpin, HIGH);
}

void loop() {
  // print the sensor values:
  Serial.print(analogRead(xpin));
  // print a tab between values:
  Serial.print("\t");
  Serial.print(analogRead(ypin));
  // print a tab between values:
```

```

Serial.print("\t");
Serial.print(analogRead(zpin));
Serial.println();
// delay before next reading:
delay(100);
}

```

3.7 Motor

```

const int pwm = 2 ; //initializing pin 2 as pwm
const int in_1 = 8 ;
const int in_2 = 9 ;
//For providing logic to L298 IC to choose the direction of the DC motor

void setup() {
  pinMode(pwm,OUTPUT) ; //we have to set PWM pin as output
  pinMode(in_1,OUTPUT) ; //Logic pins are also set as output
  pinMode(in_2,OUTPUT) ;
}

void loop() {
  //For Clock wise motion , in_1 = High , in_2 = Low
  digitalWrite(in_1,HIGH) ;
  digitalWrite(in_2,LOW) ;
  analogWrite(pwm,255) ;
  /* setting pwm of the motor to 255 we can change the speed of rotation
  by changing pwm input but we are only using arduino so we are using highest
  value to driver the motor */
  //Clockwise for 3 secs
  delay(3000) ;
  //For brake
  digitalWrite(in_1,HIGH) ;
  digitalWrite(in_2,HIGH) ;
  delay(1000) ;
  //For Anti Clock-wise motion - IN_1 = LOW , IN_2 = HIGH
  digitalWrite(in_1,LOW) ;
  digitalWrite(in_2,HIGH) ;
  delay(3000) ;
  //For brake
  digitalWrite(in_1,HIGH) ;
  digitalWrite(in_2,HIGH) ;
  delay(1000) ;
}

```

3.8 Servo

```
#include <Servo.h>
```

```

Servo myservo; // create servo object to control a servo
// twelve servo objects can be created on most boards

```

```

int pos = 0; // variable to store the servo position

void setup() {
  myservo.attach(9); // attaches the servo on pin 9 to the servo object
}

void loop() {
  for (pos = 0; pos <= 180; pos += 1) { // goes from 0 degrees to 180 degrees
    // in steps of 1 degree
    myservo.write(pos); // tell servo to go to position in variable 'pos'
    delay(15); // waits 15ms for the servo to reach the position
  }
  for (pos = 180; pos >= 0; pos -= 1) { // goes from 180 degrees to 0 degrees
    myservo.write(pos); // tell servo to go to position in variable 'pos'
    delay(15); // waits 15ms for the servo to reach the position
  }
}

```

3.9 Bluetooth

```

/*
* BluetooH Basic: LED ON OFF - Avishkar
* Coder - Mayoogh Girish
* Website - http://bit.do/Avishkar
* Download the App : https://github.com/Mayoogh/Arduino-Bluetooth-Basic
* This program lets you to control a LED on pin 13 of arduino using a bluetooth
module
*/
char data = 0; //Variable for storing received data
void setup()
{
  Serial.begin(9600); //Sets the baud for serial data transmission
  pinMode(13, OUTPUT); //Sets digital pin 13 as output pin
}
void loop()
{
  if(Serial.available() > 0) // Send data only when you receive data:
  {
    data = Serial.read(); //Read the incoming data & store into data
    Serial.print(data); //Print Value inside data in Serial monitor
    Serial.print("\n");
    if(data == '1') // Checks whether value of data is equal to 1
      digitalWrite(13, HIGH); //If value is 1 then LED turns ON
    else if(data == '0') // Checks whether value of data is equal to 0
      digitalWrite(13, LOW); //If value is 0 then LED turns OFF
  }
}

```

Appendix E: User manual

3.10 System overview

SS is a smart suitcase that will follow the user wherever he goes. Apart from this it also has additional features such as lost mode, bag fall detection and an LCD to display the user information. The bag will mainly be used by commuters, handicapped people and others in indoor facilities

3.11 General information

This is the manual for the SS that will be used to Run and debug the system. The SS is a complicated machine that integrates many features such as user following, manual mode, distress SMS and bag fall detection

3.12 Getting started

3.13

3.14 Modes

The SS mainly has 2 modes of operation these include the autonomous mode and the manual mode. In the sections below. The use of each mode has been described

Manual mode

To use the suitcase in manual mode follow these steps:

1. Keep the suitcase on a flat surface
2. Turn on your android smartphone
3. Turn on the suitcase main switch
4. Verify the blinking LED on the suitcase Bluetooth LED
5. Go to Bluetooth settings on the phone and pair with "HC06"
6. Enter the password 1234
7. Now open the control app on the android smartphone
8. Press any of the 5 buttons to move the suitcase manually

Autonomous mode

1. Keep the suitcase on a flat surface
2. Turn on the suitcase main switch
3. Wear the detector on your leg
4. Stand 20 cm in front of the suitcase and let it configure
5. Start walking and medium to slow speed
6. The will start following autonomously
7. The bag will beep if it falls down

Lost mode SMS

1. Go to SMS settings on your phone

2. Send “LOST ” to +9663642885
3. The bag will send an SMS with the location

3.15 Warnings

1. Do not use in rain
2. Do not use on wet surfaces
3. Do use outdoor
4. Do not sit on the bag
5. Do not use in extremely steep surfaces

3.16 Possible errors and fixes

Bag not moving

1. Check main switch
2. Recharge battery

Bag not following

1. Use proper detecting pattern
2. Check main switch
3. Recharge battery

Bag not sending SMS

1. Recharge the SIM card
2. Check main switch
3. Recharge battery

LCD not working

1. Check main switch
2. Recharge battery

WHAT IS SS?

SS is a smart suitcase that will follow the user wherever he goes. Apart from this it also has additional features such as lost mode, bag fall detection and an LCD to display the user information. The bag will mainly be used by commuters, handicapped people and others in indoor facilities

OBJECTIVES

The **Autonomous Smart suitcase or SS** has the following objectives

Autonomous user following mode: ensures that the bag follows the user when he or she walks

Lost mode: With the lost mode the suitcase can be contacted via internet and it sends out the GPS address and automatically plays a buzzer. If the suitcase is nearby it will make a lough sound and display on the LCD details of the owner

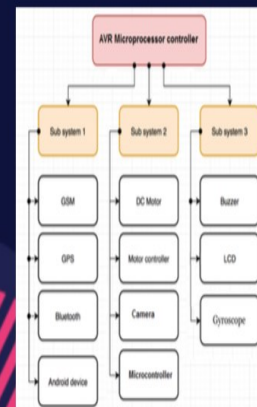
Other features: The suitcase will also have other features such as the following

Sensing the orientation using accelerometer

PRINCE MOHAMMAD UNIVERSITY

AUTONOMOUS SMART SUITCASE (SS)

SENIOR DESIGN PROJECT (FALL 2018-19)



PROJECT FEATURES

- The body of the **Smart suitcase or SS** is sturdy and made of rugged material
- Image recognition sensors are used as primary technology to enable following the owner of the **Smart suitcase or SS**
- The **Smart suitcase or SS** communicates with the user using Bluetooth and the smart suitcase can also be controlled **manually** using the app
- Users can turn on lost mode of the **Smart suitcase or SS** and the following will be done

GPS coordinates are sent

PROJECT SUB -SYSTEMS

Autonomous smart suitcase or ASS is divided into 3 main sub systems they include the following:

Subsystem 1: Wireless communication

- a) GSM
- b) GPS
- c) Bluetooth
- d) Android device

Subsystem 2: User following

- a) DC motor
- b) Motor controller
- c) camera

Subsystem 3: Sensory system

- a) Buzzer
- b) LCD
- c) Gyroscope

Engineering or technology is all about using the power of science to make life better for people, to reduce cost, to improve comfort, to improve productivity, etc.

- N. R. Narayana Murthy -