DESCRIPTION

The Kimat - Mobile Robot Shield is a compact, Arduino – Compatible, motor driver shield with pin headers for IR sensors, Ultrasonic sensors and a Servo motor. The motor driver has 2 individual channels and can accommodate a 2 or 4 wheel robot. Each channel can deliver a continuous current of 1.2A (surge up to ~3A). This shield was designed with ease of use in mind: all the essential parts of a mobile robot have been assigned a connector onboard the shield. This greatly simplifies wiring, reduced the number of boards used and the need for soldering is eliminated. The Kimat Mobile Robot (Mobot) Shield is designed and made by Layad Circuits Electronics Engineering.

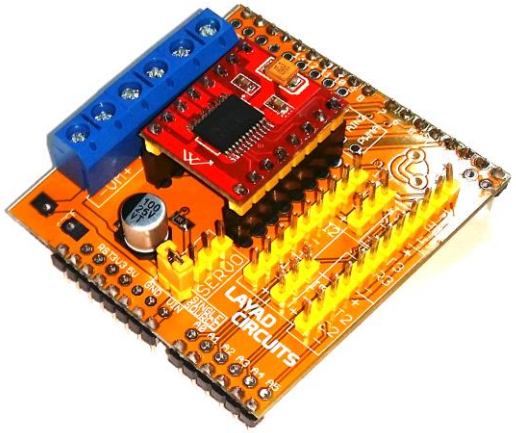

Figure 1: The Kimat Mobile Robot Shield

FEATURES and SPECIFICATIONS

- Integrated motor driver and connectors for a maximum of 5 IR sensors and maximum of 3 Ultrasonic Sensors and 1 Servo motor.
- Motor Driver: TB6612FNG
- Number of Channels: 2
- Max. Motor Voltage = 15V
- Max. Continuous Current per Channel =1.2A
- Max. Surge Current per Channel = 3.6A
- Removable Core Driver Board
- Arduino Compatible

PIN ASSIGNMENTS

Kimat Mobot Shield Pin	Assigned to Arduino Pin
TB6612FNG - PWMA	3
TB6612FNG - AIN1	2
TB6612FNG - AIN2	4
TB6612FNG - PWMB	6
TB6612FNG - BIN1	7
TB6612FNG - BIN2	5
TB6612FNG - STBY	8
SERVO – S (via resistor)	9
IR1	10
IR2	11
IR3	A0
IR4 / T3 (Shared)	A1
IR5 / E3 (Shared)	A2
T1	12
E1	A3
T2	A4
E2	A5
unused	D0
unused	D1
unused	D13

Labels:
IRx – are connectors meant for IR line tracing or IR distance sensors
Tx and **E**x – are ultrasonic meant for ultrasonic sensors. T refers to the Trigger pin and E refers to the Echo pin.

The Arduino pins 2-8 are connected to the TB6612FNG chip and are not available for other use. All other pins are free. However, the shield has onboard connectors for a maximum of 5 IR sensors and a maximum of 3 ultrasonic sensors. The last ultrasonic sensor with pins labeled as T3 and R3, are shared with IR4 and IR5 respectively. Thus, if all 5 IR sensor pins are used, a maximum of only 2 ultrasonic sensors may be

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connected. If only 3 IR sensor pins are used, a maximum of 3 ultrasonic sensors may be installed. There is also one pin with a current limiting resistor meant for use with a servo motor.

TERMINAL BLOCKS

There are 3 terminal blocks at the top of the shield.

Terminal Block Label (Bottom of PCB)	**Purpose**
MOTOR POWER	This is the power source of the motors. If the single source jumper is installed, the motor power is derived from the VIN pin of the Arduino/Shield
MOTOR A	Connector for DC Motor A
MOTOR B	Connector for DC Motor B

If using 4 wheels, connect the 2 left motors on one connector and the other 2 right motors on the other connector. Therefore, the software for a 2-wheeled and 4-wheeled robot is essentially the same.

SINGLE POWER SOURCE OPTION

The Mobile Robot Shield has a pin header labeled SINGLE SOURCE with a microjumper provided. If the microcjumper is installed, The Arduino VIN pin and the Motor Power Supply is connected. This simplifies wiring since the user only needs to apply power at the Arduino DC Jack. The same power is then transferred to the shield via the VIN pin. If the microjumper is not installed, apply power to the motors via the terminal blocks labeled VM / MOTOR POWER.

Figure 2: The Single Source pin header with microjumper installed

When using the single power source option, please take note of the following

- **When micro jumper is installed, DO NOT connect anything in the VM terminals**!
- **If external power source is desired, REMOVE the micro jumper first!**
- Motor voltage must match Arduino Voltage (6-12V)
- There is a 1A power diode between the DC jack and VIN pin of the Arduino. This can take in larger surge current but make sure your motors and Arduino do not exceed 1A continuous current. This is not a problem if using the Saleng Uno. The Saleng Uno uses a 5A diode instead of 1A and hence is able to handle small and large motors and other circuits.

MOTOR POWER CAPACITOR SLOT

If for some reason you need to include a capacitor at the motor power source line, there is a slot ready made for this close to the Motor Power terminal block.

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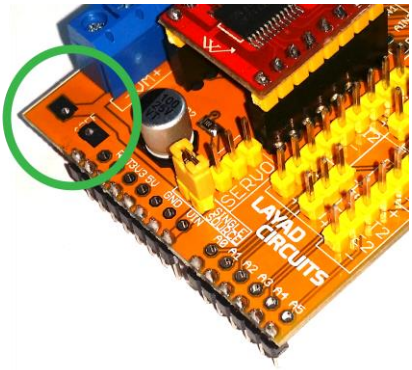

Figure 3: Capacitor slot for the motor power line

If using larger capacitors that do not fit the slot, you may simply install it at the VM terminal block. One reason you may need a capacitor is if your motor power source is unable to provide large currents at very short time intervals. Exercise caution when selecting the capacitor voltage rating: because we should not expect voltages above 15V at the VM terminals, you may use 16V capacitors. However, if your motor voltage is close to 15V, higher voltage ratings, such as 25V,35V or 50V, is required to account for transients.

CODING TIPS

The Mobile Robot Shield is easy to use even without using a library. Follow these pointers in writing your code:

- When the shield is installed on top of the Arduino, the TB6612's control pins are effectively connected to the Arduino pins 2-8 as in the figure below. Do note that the figure does not show the sensor headers.

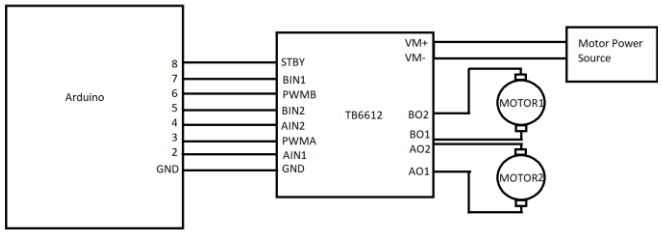

Figure 4: Equivalent circuit when shield is installed

- Arduino pins 2-8 shall be used as outputs.
- Set pin 8 (STBY) as HIGH to enable the motor driver. A LOW disables the driver.
- Pins 3 (PWMA) and 6(PWMB) are the pins used to control the speed of the motors. Applying PWM signals via analogWrite() on pins 3 and 6 controls the speed of the motors. If speed control is not needed, simply set pins 3 and 6 HIGH using digitalWrite() to keep the motors at full speed.
- Pins 2 and 4 control the direction of motor(s) 1 while pins 5 and 7 control the direction of motor(s) 2. Follow the table below:

xIN1	xIN2	Motor Reaction
LOW	HIGH	Move in One Direction
HIGH	LOW	Move in Opposite Direction
LOW	LOW	Motor Stops
HIGH	HIGH	Short Break, Motor stops

EXAMPLE CODE WITHOUT LIBRARY

This code demonstrates the basic movements of a wheeled mobile robot. The code cycles through forward, backward, left and right movements. If you are not getting the correct movement, check that your left

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and right motor wirings are consistently wired to xIN1 and xIN2.

```
/*
 * Install right motor(s) on AIN1 & AIN2
 * Install left motor(s) on BIN1 & BIN2
 */

#define AIN1 2
#define BIN1 7
#define AIN2 4
#define BIN2 5
#define PWMA 3
#define PWMB 6
#define STBY 8

void speedSetting(byte val)
{
  analogWrite(PWMA,val);
  analogWrite(PWMB,val);
}

void forward()
{
  digitalWrite(AIN1,LOW);
  digitalWrite(AIN2,HIGH);
  digitalWrite(BIN1,LOW);
  digitalWrite(BIN2,HIGH);
}

void backward()
{
  digitalWrite(AIN1,HIGH);
  digitalWrite(AIN2,LOW);
  digitalWrite(BIN1,HIGH);
  digitalWrite(BIN2,LOW);
}

void turnleft()
{
  digitalWrite(AIN1,LOW);
  digitalWrite(AIN2,HIGH);
  digitalWrite(BIN1,HIGH);
  digitalWrite(BIN2,LOW);
}

void turnright()
{
  digitalWrite(AIN1,HIGH);
  digitalWrite(AIN2,LOW);
  digitalWrite(BIN1,LOW);
  digitalWrite(BIN2,HIGH);
}

void motorstop()
{
  digitalWrite(AIN1,LOW);
  digitalWrite(AIN2,LOW);
  digitalWrite(BIN1,LOW);
  digitalWrite(BIN2,LOW);
}

void shortbreak()
{
  digitalWrite(AIN1,HIGH);
  digitalWrite(AIN2,HIGH);
  digitalWrite(BIN1,HIGH);
  digitalWrite(BIN2,HIGH);
}


void setup() {
  pinMode(AIN1,OUTPUT);
  pinMode(AIN2,OUTPUT);
  pinMode(BIN1,OUTPUT);
  pinMode(BIN2,OUTPUT);
  pinMode(STBY,OUTPUT);
  digitalWrite(STBY,HIGH);//enable driver
  speedSetting(255); //set to full speed
  delay(3000); // add 3s delay
}


void loop() {
  forward();delay(600);
  shortbreak();delay(100);
  motorstop();delay(2000);

  backward();delay(600);
  shortbreak();delay(100);
  motorstop();delay(2000);

  turnleft();delay(1000);
  shortbreak();delay(100);
  motorstop();delay(2000);

  turnright();delay(1000);
  shortbreak();delay(100);
  motorstop();delay(2000);
}
```


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LIBRARY

Sparkfun has created a motor driver library compatible with the Kimat Mobile Robot Shield. You may download it Sparkfuns Github page:

https://github.com/sparkfun/SparkFun_TB6612FNG_Arduino_Library

Edit the pin assignments of the example code and you may now test the motor driving functionality of the shield. Below is an edited version of that example code that rotates the motor back and forth. This can be used as a first test and reference code:

```
#include <SparkFun_TB6612.h>

// Pins for all inputs, keep in mind the PWM defines
// must be on PWM pins
// the default pins listed are the ones used on the
// Redbot (ROB-12097) with
// the exception of STBY which the Redbot controls
// with a physical switch
#define AIN1 2
#define BIN1 7
#define AIN2 4
#define BIN2 5//8
#define PWMA 3//5
#define PWMB 6
#define STBY 8//9

// these constants are used to allow you to make
//your motor configuration
// line up with function names like forward.  Value
//can be 1 or -1
const int offsetA = 1;
const int offsetB = 1;

// Initializing motors.  The library will allow you
//to initialize as many
// motors as you have memory for.  If you are using
//functions like forward
// that take 2 motors as arguements you can either
//write new functions or
// call the function more than once.
Motor motor1 = Motor(AIN1, AIN2, PWMA, offsetA,
STBY);
Motor motor2 = Motor(BIN1, BIN2, PWMB, offsetB,
STBY);

void setup()
{
 //Nothing here
}

void loop()
{
   //Use of the drive function which takes as
   //arguements the speed
   //and optional duration.  A negative speed will
   //cause it to go
   //backwards.  Speed can be from -255 to
   //255.  Also use of the
   //brake function which takes no arguements.
   motor1.drive(255,1000);
   delay(1000);
   motor1.drive(-255,1000);
   motor1.brake();
   delay(1000);

   //Use of the drive function which takes as
   //arguements the speed
   //and optional duration.  A negative speed will
   //cause it to go
   //backwards.  Speed can be from -255 to
   //255.  Also use of the
   //brake function which takes no arguements.
   motor2.drive(255,1000);
   delay(1000);
   motor2.drive(-255,1000);
   motor2.brake();
   delay(1000);

   //Use of brake again.
   brake(motor1, motor2);
   delay(1000);

}
```

Note that the above is the code for the motor driver only. If you have connected IR sensors, ultrasonic sensors or servo motor, please refer to the individual product datasheets. There should also be numerous references online as these are very common parts for Arduino.

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SIMPLE LINE TRACING CODE

The following code demonstrates the basic structure of a simple line tracing robot. It uses a Mobile Robot Shield with an Uno and 3 Saleng Tracker (by Layad Circuits) sensors.

A lot of different factors will affect the performance of this code such as:

- Motor specifications
- Power/Battery performance
- Assembly and Build
- Sensors used
- Thickness of line
- Complexity of line route
- Distance between sensors

For better performance, consider:

- Adding more sensors for better detection of lines and line shape
- Add code to handle different line shapes (e.g. curves, U-turns, crossings)
- Improving traction of wheels/floor
- Adding automatic speed control code to better handle curves
- Add code to for timing motor motion based on motor performance and line shape
- Add PID algorithm for smoother motion

```
/* Hardware Notes:
```

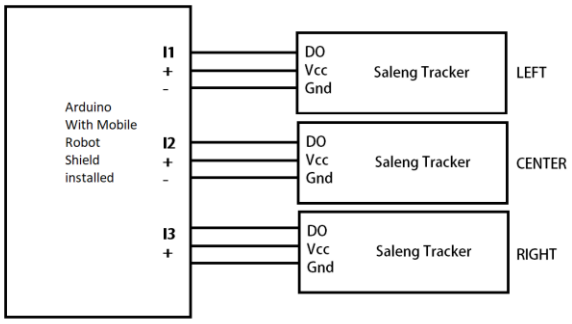

Figure 5: Wiring for simple line tracing robot

```
 /* Hardware notes
 * 3 Saleng Trackers on pins headers
 * I1(left),I2(center) and I3(right)
 * Install right motor(s) on AIN1 & AIN2
 * Install left motor(s) on BIN1 & BIN2
 */

// change below to define if line
// is black on white background or
// white on black background.
// These define the sensor value when
// under black and white surface
// You may also use the DO and ~DO
// pins of the Saleng Tracker to
// change line configuration

#define BLK LOW  // line
#define WHT HIGH // background

#define AIN1 2
#define BIN1 7
#define AIN2 4
#define BIN2 5
#define PWMA 3
#define PWMB 6
#define STBY 8
#define SENSOR_L A0
#define SENSOR_C 11
#define SENSOR_R 10

byte sensorL, sensorC, sensorR;


void speedSetting(byte val)
{
  analogWrite(PWMA,val);
  analogWrite(PWMB,val);
}

void forward()
{
  digitalWrite(AIN1,LOW);
  digitalWrite(AIN2,HIGH);
  digitalWrite(BIN1,LOW);
  digitalWrite(BIN2,HIGH);
}

void backward()
{
  digitalWrite(AIN1,HIGH);
  digitalWrite(AIN2,LOW);
  digitalWrite(BIN1,HIGH);
  digitalWrite(BIN2,LOW);
}
```


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```
void turnleft()
{
  digitalWrite(AIN1,LOW);
  digitalWrite(AIN2,HIGH);
  digitalWrite(BIN1,HIGH);
  digitalWrite(BIN2,LOW);
}

void turnright()
{
  digitalWrite(AIN1,HIGH);
  digitalWrite(AIN2,LOW);
  digitalWrite(BIN1,LOW);
  digitalWrite(BIN2,HIGH);
}

void motorstop()
{
  digitalWrite(AIN1,LOW);
  digitalWrite(AIN2,LOW);
  digitalWrite(BIN1,LOW);
  digitalWrite(BIN2,LOW);
}

void shortbreak()
{
  digitalWrite(AIN1,HIGH);
  digitalWrite(AIN2,HIGH);
  digitalWrite(BIN1,HIGH);
  digitalWrite(BIN2,HIGH);
}


void setup() {
  pinMode(SENSOR_L,INPUT);
  pinMode(SENSOR_C,INPUT);
  pinMode(SENSOR_R,INPUT);
  pinMode(AIN1,OUTPUT);
  pinMode(AIN2,OUTPUT);
  pinMode(BIN1,OUTPUT);
  pinMode(BIN2,OUTPUT);
  pinMode(STBY,OUTPUT);
  digitalWrite(STBY,HIGH);//enable driver
  //we use a slow speed to avoid
  // overshooting lines
  // and conserve battery
  // full speed = 255
  speedSetting(32);
  delay(5000); // add 5s delay
  Serial.begin(115200);
}
```


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```
void loop() {
  // read and store all sensors
  sensorL = digitalRead(SENSOR_L);
  sensorC = digitalRead(SENSOR_C);
  sensorR = digitalRead(SENSOR_R);

  if(sensorL == BLK && sensorC == BLK && sensorR == BLK)
  {
    backward(); // assume we overshot line
  }
  else if(sensorL == WHT && sensorC == BLK && sensorR == BLK)
  {
    turnleft();
  }
  else if(sensorL == WHT && sensorC == BLK && sensorR == WHT)
  {
    // confused! Just move forward
    forward();
  }
  else if(sensorL == BLK && sensorC == BLK && sensorR == WHT)
  {
    turnright();
  }
  else if(sensorL == BLK && sensorC == WHT && sensorR == BLK)
  {
    forward();
  }
  else if(sensorL == WHT && sensorC == WHT && sensorR == BLK)
  {
    turnleft();
  }
  else if(sensorL == WHT && sensorC == WHT && sensorR == WHT)
  {
    forward();
  }
  else if(sensorL == BLK && sensorC == WHT && sensorR == WHT)
  {
    turnright();
  }
}
```

FREQUENTLY ASKED QUESTIONS:

Q: I tried the sample code with the library but my motors turn in just one direction, what is wrong?

A: Your power source is unable to provide sufficient current during sudden direction changes. There are 3 solutions:

- Use a power source with sufficient current
- Add delays in between direction changes to give time for power to stablelize
- Add a large capacitor at the VM terminals. You may directly connect it at the VM terminal block

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Q: When the "Single Source" microjumper is installed, do I need power for both Arduino and Shield?

A: NO! You MUST use only one power source when the micro jumper is installed. Apply a voltage acceptable to both Arduino and motors via the Arduino DC Jack. Note that a 1A diode is in between the Arduino's DC jack and VIN pin where the motors are powered from. This diode may be damaged if the total current drawn byt eh motos and Arduino exceeds this 1A rating. This is not a problem in the Saleng Uno which has a 5A diode instead of 1A.

Q: When the "Single Source" microjumper is installed, can I use the blue VM terminal block to power both Arduino and Shield?

A: Yes, but beware. While this may solve the problem of the limited 1A rating of the reverse polarity protection diode of the Arduino, it exposes you to possible hardware faults when you interchange the polarities of the power connected to VM.

Q: If the microjumper is not installed, how do I power the shield and Arduino?

A: use separate power sources. One for the Arduino via its DC jack or USB port and another power source for the motors via the VM pin

Q: What power supply / battery voltage is to be used?

A: When microjumper is installed, you need to fulfill the voltage requirements of botht eh Arduino and the Motors. For example, if you are using 3-9V motors, then you may use 6-9V power source (battery) since the Arduino can operate at 6-12V. The intersection of both motor and Arduino power requirement is 6-9V.

Q: What kind of power supply/battery can be used?

A: Nothing specific since this is mostly dependent on the motor being used. Check the motor voltage required and current consumption. A good estiamte is to use a power supply that can deliver, and sustain, twice the maximum current drawn by the motor. For batteries, the battery capacity will determine the running time of the robot. Choose the highest capacity that is practical.

Q: Can I use power bank?

A: For the Arduino alone (microjumper not installed)? Yes. For both motor and Arduino? It depends. 5V is generally not sufficient for powering 5V Arduino boards via the DC jack, you may need a step-up DC-DC converter to do so.

Q: Can I use the shield for 4-wheel and 2-wheeled robots?

A: Absolutely! A 4-wheeled robot has the same code as 2-wheeled robot if both left motors are in parallel and connected to one channel of the driver and the two right motors connected in parallel to the other channel. Just make sure your combined continuous current does not exceed 1.2A per channel. The common plastic geared DC motors with yellow gearbox draw some ~250mA, two of these in parallel would mean a current of ~500mA. Thus, you may use these types of motors, either as 2-wheeled or 4-wheel robots, with the shield.

Q: What powers the shield?

A: Power for the logic circuit of the driver chip is taken from the 5V pin of the Arduino, not from VM or VIN. On the other hand, the motor(s) are powered from the VM or VIN(microjumper installed).

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Q: Which IO pins are used by the shield?
A: The motor driver section uses pins 2-8. Do not use these pins.

Q: Which IO pins are free?
A: You may use all pins except pins 2-8. There are parallel hole pads for all unused pins, you may installe male or female pin headers on those pads if you wish so. Note that some pins are used for the sensor header connectors on the shield. If you are using the headers, then those pins are no longer free. Refer to the Pin Assignment table the IO pins used for the headers and motor driver.

Q: Can the shield be used as a Sumobot? Line Tracing/ Line Follower robot? Obstacle Avoidance Robot?
A: Of course! We've build it for these applications. In fact, almost any mobile-wheeled robot is possible.

Q: Can I use more than 5 digital IR sensors?
A: Yes, you would just need to wire them as in a normal shield. Use the connector pads provided for all unused pins. There are a total of 13 free pins, that gives you the option to connect up to 13 digital IR sensors!

Q: Will a PID algorithm work for a line tracing application?
A: Yes, use 5 IR sensors or more for a smoother PID algorithm

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